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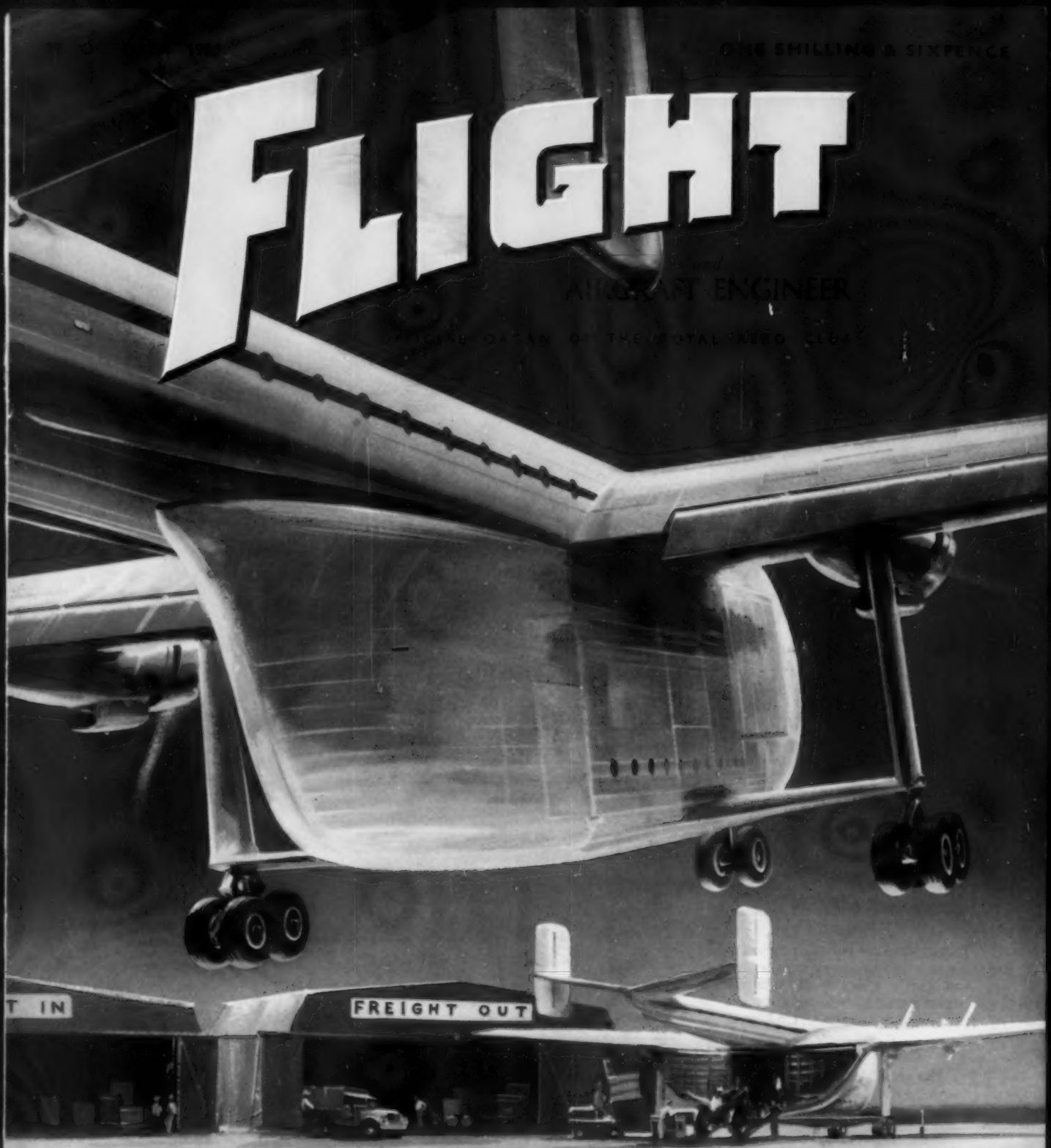

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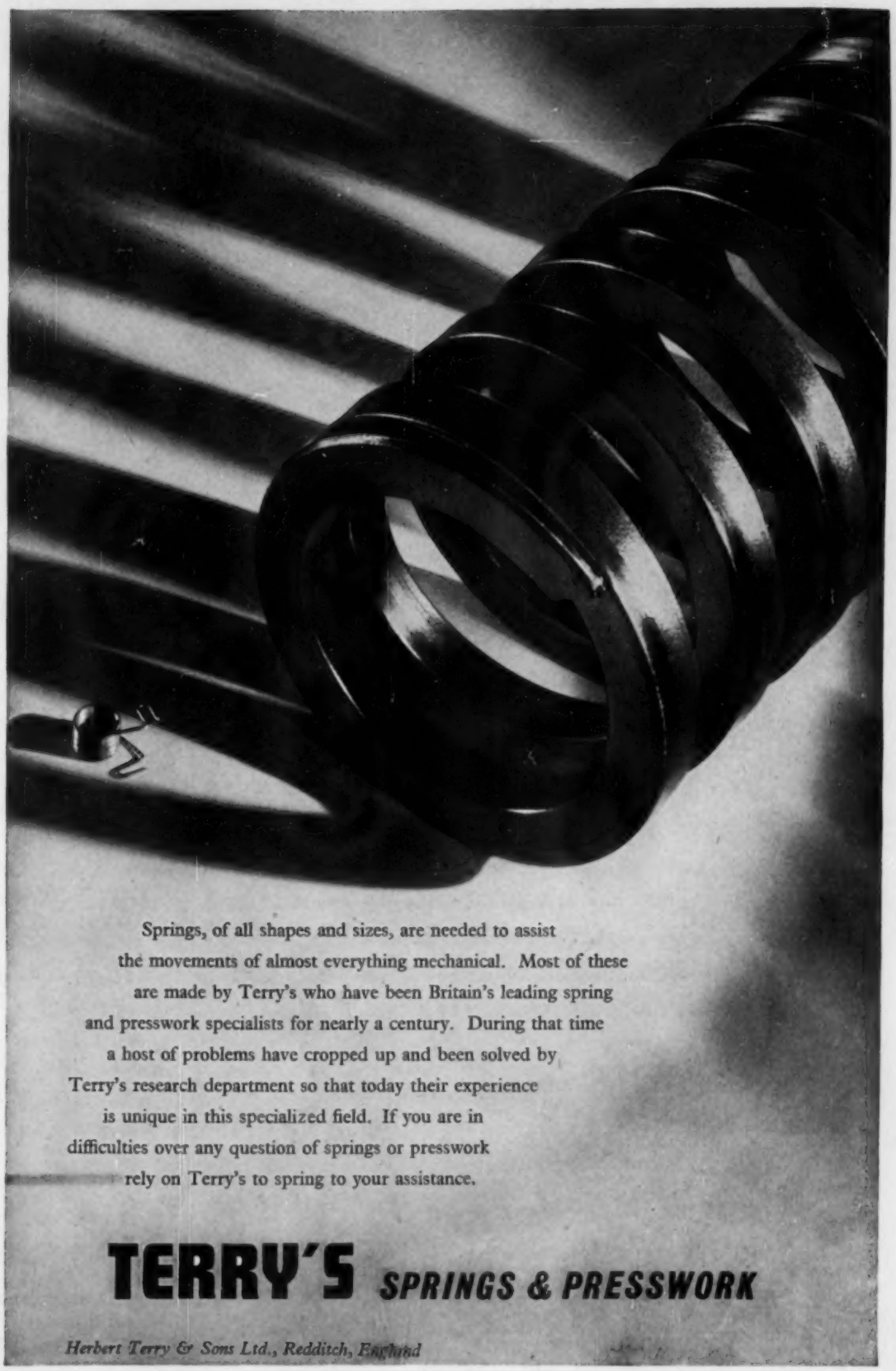
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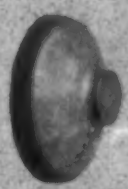

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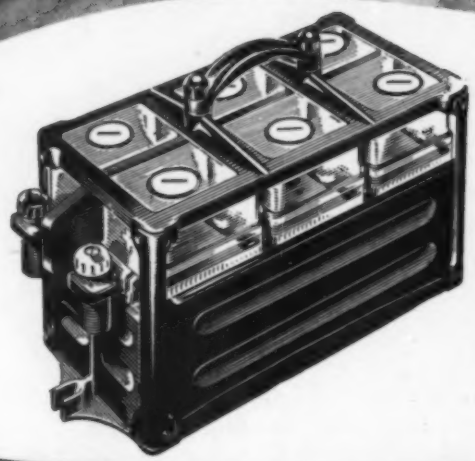

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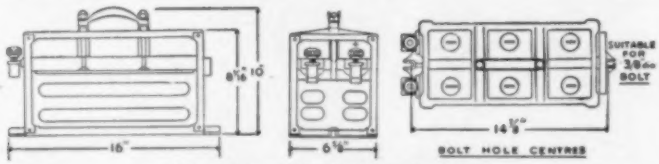

Side and end views of 6-EP19B/2 with battery layout diagram

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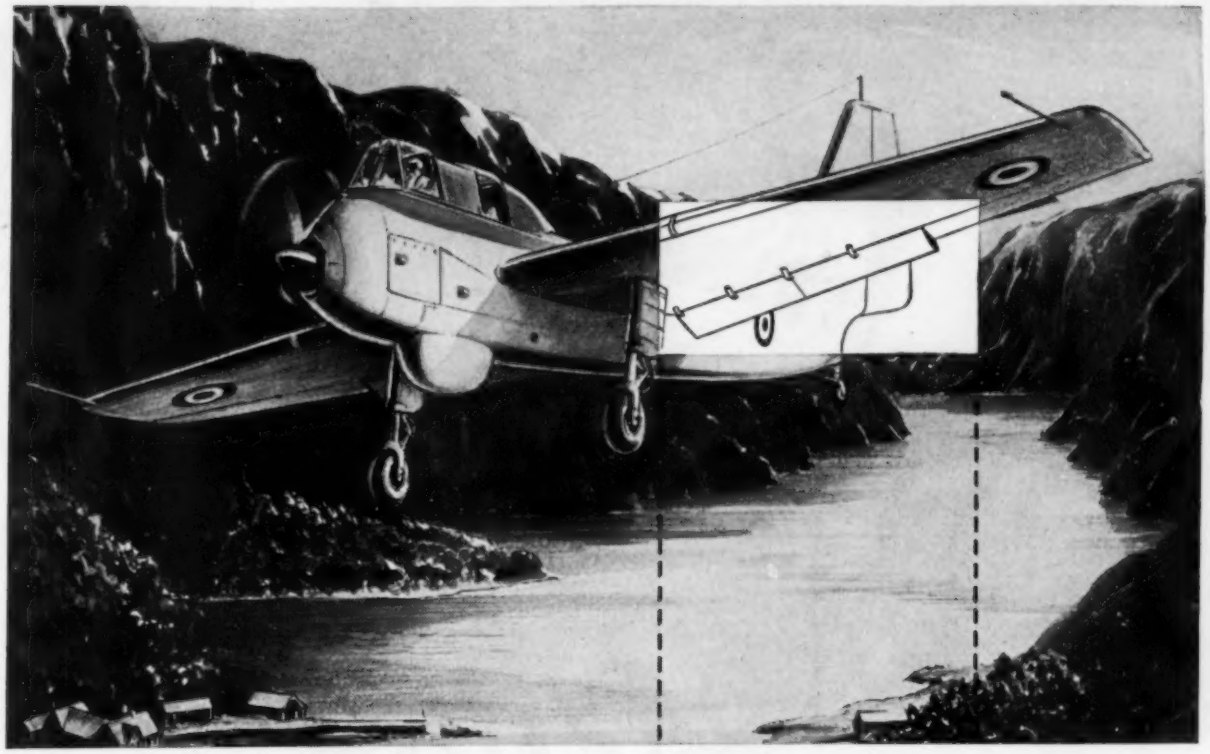

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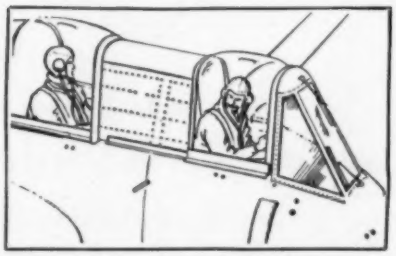

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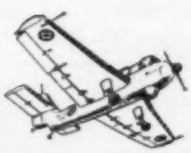

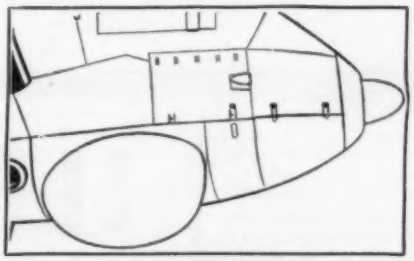

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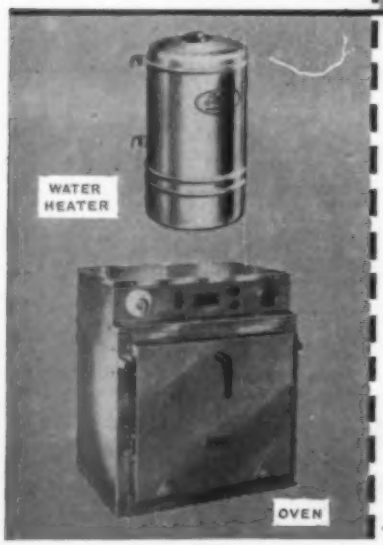

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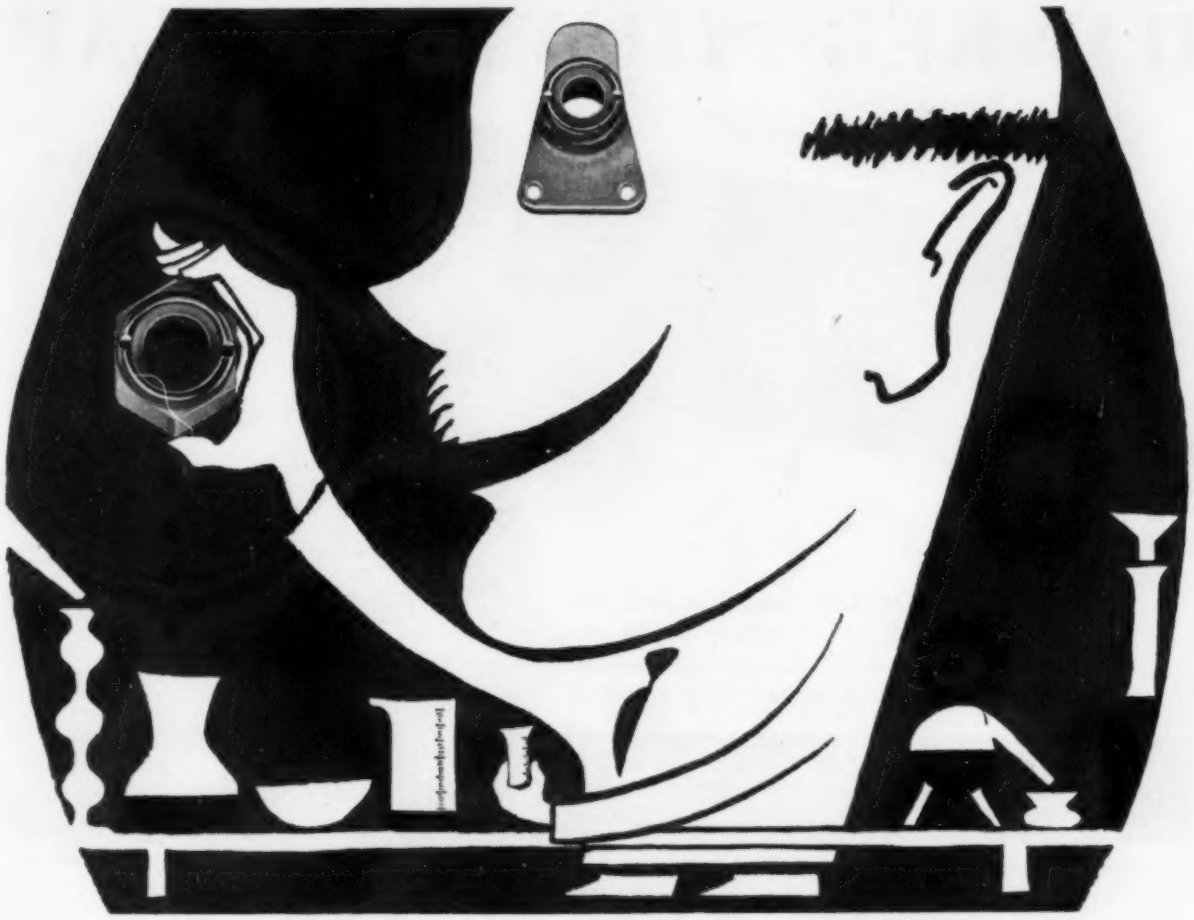

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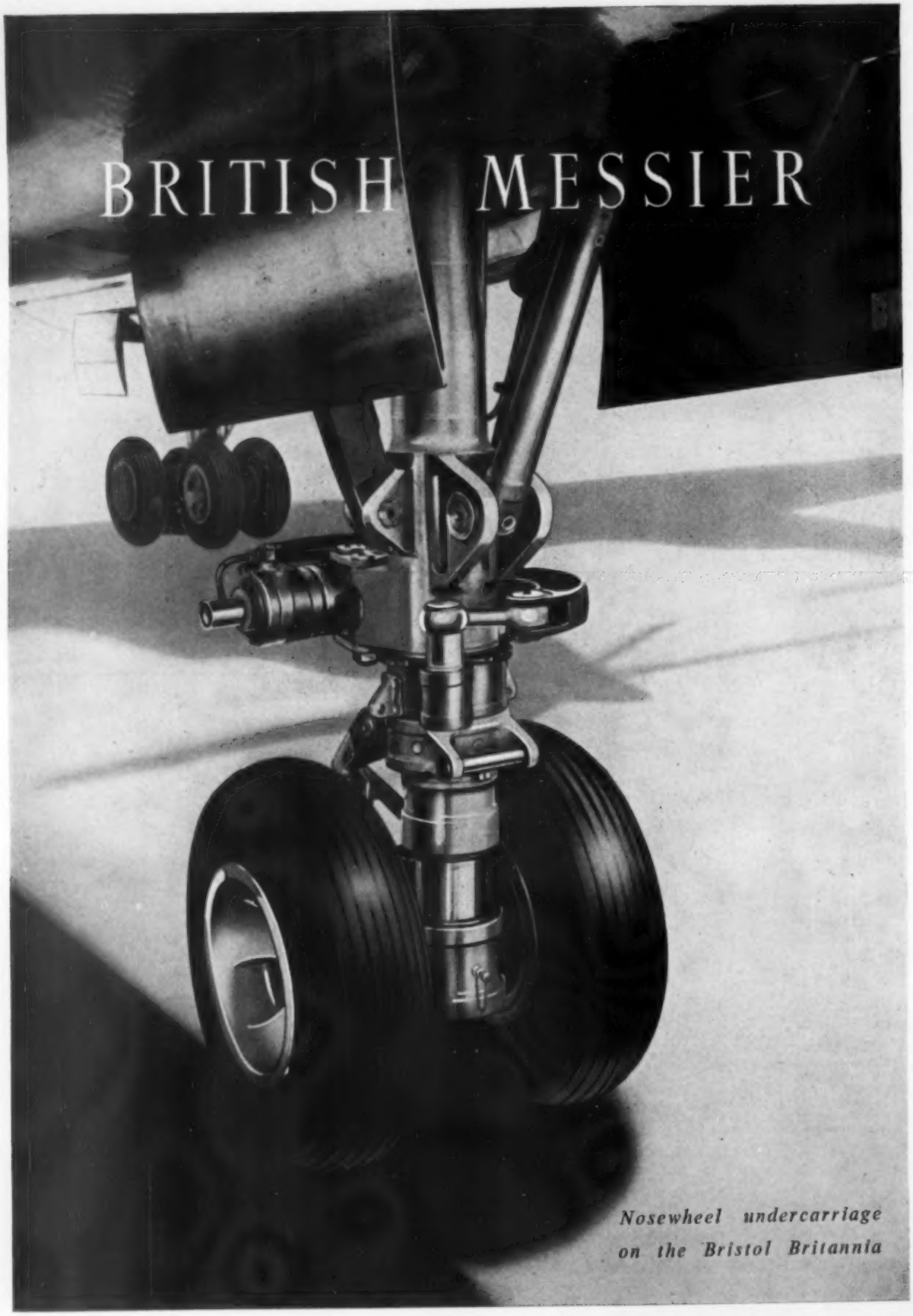

Nosewheel undercarriage on the Bristol Britannia

FLIGHT
and
AIRCRAFT ENGINEER

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Knowledge of the Comet

WESTMINSTER, London, has during the last two weeks been the scene of perhaps the most remarkable and momentous inquiry in aviation history. While we write, during this second week, the court is still in session and nothing is yet known of its findings. The evidence which has already been given has, however, brought certain facts to light which must set both manufacturers and operators thinking profoundly.

It is only natural for people to wonder now what might be discovered if other types of aircraft were subjected to an intensive and microscopic analysis similar to that of the Comet 1. Bearing in mind all the painstaking work which went into Comet development they will also ask themselves how a practical programme of testing, inspection and trials can be evolved for new aircraft which will ensure that disasters of this kind will not occur again.

As one reads the 3-inch thick printed report of the accident investigation with its tens of thousands of words of detailed explanations, its hundreds of diagrams and photographs and its exhaustive deductions and eliminations leading stage by stage to a coherent account of unseen events, one cannot but feel the most profound admiration for the work of Sir Arnold Hall and his colleagues at Farnborough. This report on the investigation may, in fact, be described as one of the few pleasing matters arising from the whole unhappy affair, for it confirms beyond doubt the capacity and the remarkable knowledge and ability of our scientists. It gives the promise that in spite of the imperfections of all man-made machines, and in spite also of the many unknowns, it is not beyond the ability or knowledge of our technicians to design and produce air transports of the new order that will be both safe and reliable.

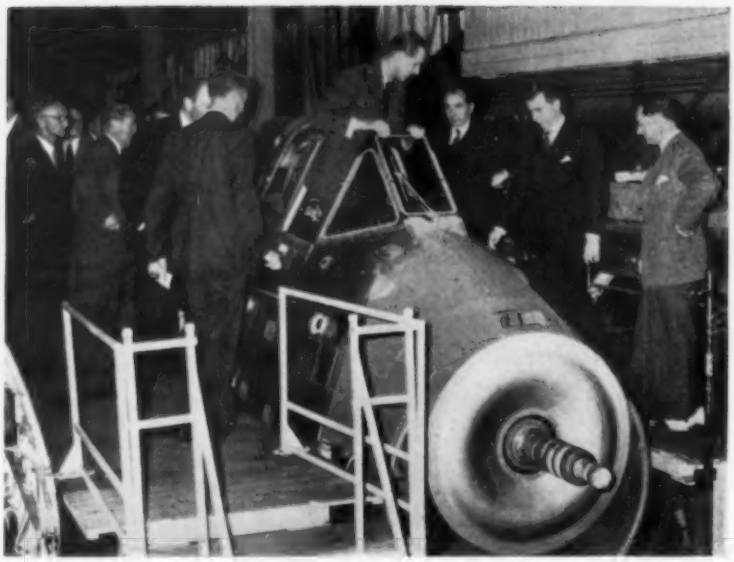
The Comet disasters came as a tremendous shock and discouragement, and their repercussions have been felt the world over—more particularly by others who are working on high-performance jet and turboprop airliners. The knowledge and experience which have now been gained are, however, two important items on the credit side, and they will help to restore confidence. In passing it may be remarked that the de Havilland Company were considering nearly ten years ago many of the problems now being discussed in the inquiry. Others among the considerations were then unknown and unsuspected. The company were truly pioneering and, as it seemed for many thousands of hours of airline flying, with complete success.

Hitherto it had been believed that the various methods of testing and inspection which had stood the test of years when simple, low-and-slow-operating aircraft were concerned, would, with certain logical extensions, be satisfactory for 500 m.p.h. 40,000ft transports. Clearly this is not so. The problem of fatigue is one to be tackled at the detail design stage; it remains to be seen how in this and other countries entirely new and even more relentless testing and examination can be introduced to ensure at least as great a degree of safety for the passenger (at the much greater speeds and altitudes) as in the past.

Already it is realized and accepted by companies concerned with new aircraft that water-tank testing of fuselages may become a practice, and fuel and electrical systems will require even closer scrutiny. It seems certain, too, that many more hours of prototype and route flying will also be required before a licience to carry passengers will be issued. This all means that the A.R.B. as well as the manufacturers and operators are faced with heavy new responsibilities. It seems inevitable that all new high-performance aircraft will take longer to develop and introduce into service and that they will be more expensive. Weight increases may also have to be accepted in the cause of safety and insurance against fatigue and fire.

There are some who (particularly in retrospect) would say that it was naïve to expect successfully to double transport speeds and operating heights in a single stage. Yet every new step, especially if it is a bold and enterprising one, involves a calculated risk. Everyone knows this well enough, and fortunately, we believe, very few are so lacking in spirit that they stand still or condemn others for pressing on.

FROM ALL QUARTERS



THE DUKE AND THE GANNET: On his visit to the Hayes factory of the Fairey Aviation Co., Ltd., on October 19th, the Duke of Edinburgh, as seen, inspected a Gannet on the production line. The Duke was also shown display panels depicting the work of other companies in the Fairey group, and later visited the Weapon Division at Heston. Second from right in this picture is R. G. Slade, chief test pilot, and next to him is Mr. T. F. Park, works manager, Hayes. On the left of the picture are Mr. A. Vines, production manager, Mr. Richard Fairey, director, and Mr. L. Massey Hilton, director.

Canberras' Middle East Flight

NEXT Friday six Canberras of No. 57 Squadron are to take off from Cottesmore on a ten-day 7,000-mile training flight. They will visit Iraq, Jordan and Libya and will be seen at Baghdad at the time of the Trade Fair in that city. It is expected that they will be based at Habbaniya for a part of their tour. The officer in charge of the flight will be S/L. I. G. Broom, D.S.O., D.F.C., squadron commander of No. 57 Squadron.

Javelin F.R. Tests

WITH the object of assisting Flight Refuelling, Ltd., in the airborne testing of their hose and drogue equipment, and also of conducting a few dummy runs with a Javelin fitted with an "F.R." probe, a number of experimental flights have lately been made from Moreton Valence. These have also involved a Canberra and a Meteor.

Holland Buys Sabres

FOLLOWING agreement between the Dutch and American Governments, a total of 56 North American F-86K Sabre single-seat all-weather fighters will be supplied to the Royal Netherlands Air Force. Of these, 28 will be delivered under an M.D.A.P. agreement and the other 28 will be purchased by the Netherlands Government itself.

Marlins in the Med.

IT has just been disclosed that during July and August this year twelve Martin P5M Marlins of Patrol Squadron VP-44, U.S. Navy, stationed at Norfolk, Virginia, flew simulated operations over the Sudha Bay area, Rome and the Italian mainland. The test—designed to demonstrate suitability for combat duty in European waters, if needed—lasted 55 days and the seaplane tender U.S.S. *Currituck* served as a mobile maintenance base and supply source. On the transatlantic crossing the Marlins flew the Great Circle route to Pembroke Dock, thence to Taranto, which served as the main base of operations. The captain of the *Currituck* later announced "We have learned, and proved, that our ship and attached squadrons can operate efficiently and effectively many thousands of miles from home for long periods." While no rough-water landings were made in the Mediterranean, the Marlins successfully rode out waves 5 to 6ft in height while moored at Pembroke Dock.

The Alamein Memorial

ON Sunday last, before a gathering of 5,000 people, Field Marshal Viscount Montgomery unveiled the Alamein memorial to the 11,945 officers and men of the land and air forces of the Commonwealth who have no known grave. Of these 3,200 were members of the air forces and were killed while operating from bases in the Eastern Mediterranean, the Near East and East Africa.

One of two guards of honour was drawn from the ranks of the R.A.F. Regiment and the Queen's Colour of the regiment was paraded. Air Chief Marshal Sir Arthur Longmore, vice-chairman of the Imperial War Graves Commission was present.

Burmese Provosts

THE Hunting Percival Provost 53 which was demonstrated with armament in this year's S.B.A.C. Display was one of a number destined for the Burmese Air Force, and a batch of these machines is now on a delivery flight. The aircraft are in the hands of pilots provided by Field Aircraft Services, who collected them at Luton on October 25th and flew to Croydon for briefing and for departure on the following day. Each Provost has a 30-gal auxiliary tank in the fuselage, and the flight of 5,700 miles should be completed in 8-9 days and in 17 stages.

Northolt in Uniform Again

TOMORROW evening, October 30th, the last civil aircraft to make a scheduled flight from Northolt is due to take-off for Jersey. The following day Northolt will be returned to the R.A.F. after being loaned to the M.T.C.A. for the past eight years.

Northolt was originally selected as an airfield—selected, in fact, from the air—by Sir Sefton (then Major) Brancker before World War 1. Since that time, it has always been one of the R.A.F. stations in the chain of airfields defending London. Between the wars, Nos. 23, 111 and 213 squadrons were based there, and during World War 2 it came to be particularly associated with the Polish squadrons operating with the R.A.F.

After D-day, Northolt was increasingly used by Transport

DESTRUCTION TEST: The wings of Comet G-ALYU protrude, through their special watertight seals, from the great water tank at the Royal Aircraft Establishment, Farnborough, where the aircraft was subjected to some of the most thorough testing ever undergone by a civil aircraft *(see pages 638-639).* *The tank holds 200,000 gallons of water, and six minutes in the tank, wings flexing, was equal to three hours' flying.*

FASTEST AND HIGHEST? As recorded on page 640, this Sikorsky XH-39 has set up an unofficial world altitude record of 24,500ft. According to a U.S. Army announcement, a similar machine has covered a 3-km course at an average speed of 156.005 m.p.h.

Command and in February 1946 the newly constituted European division of B.O.A.C. began operations from the airfield. Subsequently, more and more civil airlines used it, and it only yielded its leading status in civil airline flying to London Airport in the early part of 1953. Until that time, it was the busiest civil airport in the United Kingdom.

Northolt never became an entirely civil airfield; R.A.F. and U.S.A.F. transport aircraft have been based there throughout the last eight years.

Belgium Evaluates Javelin

EARLY this month an evaluation team of the Belgian Air Force spent some days with the Gloster Aircraft Co., Ltd., discussing and assessing the Javelin all-weather fighter. Flights undertaken from Moreton Valence by two senior pilots and a radar expert are said to have been in line with the Belgian Government's decision "to look around for suitable and available all-weather equipment." The pilots were Lt-Col. C. Roman (a Battle of Britain pilot who won the D.S.O. and D.F.C. and now commanding officer of a Belgian fighter base), and Lt-Col. G. De Beuger, and the radar expert was Major H. Cabolet, who also flew with the R.A.F. during the war. Javelin output, incidentally, is still ahead of schedule.

Air League Lunch to General Gruenther

AT a luncheon given by the Air League of the British Empire at the Mansion House, London, last Monday, the guest of honour was General Alfred M. Gruenther, United States Army, Supreme Allied Commander in Europe. After the loyal toasts, the first speaker, Viscount Templewood, president of the Air League of the British Empire, proposed the Lord Mayor (who presided) and the Corporation of London. He thanked the Lord Mayor for allowing the luncheon to take place in the Mansion House and recalled that in over fifty years of London functions which he could remember, a member of the Bowater family had always held high office. Regarding the Air League, he said that its purpose was to instruct the British public in air matters and to stimulate the Air Ministry. It was quite essential to have an outside organization to provide this stimulation. He mentioned two particular matters with which the Air League was at present concerned, namely better conditions for the education of families of Air Force personnel and a system of State-aided insurance for the families of pilots who lost their lives in the air.

The Lord Mayor, Sir Noel Vansittart Bowater, replied to the toast and welcomed the guest of honour. He said that it was appropriate that the Air League should entertain General Gruenther in the heart of the City of London. The Lord Mayor then traced the General's distinguished career since his graduation from West Point shortly after the Great War.

In his address which followed, General Gruenther referred to his pleasure in being associated with collective security, to the concept of which he had been introduced by Sir Gladwyn Jebb. He went on to review in a masterly fashion the affairs of N.A.T.O. and E.D.C., with special reference to recent events. He said that the German contribution had now been settled at twelve divisions for the Army, 1,300 aircraft and ships for coastal duties. It would take two years from the date of ratification to prepare the ground forces and three years for the air forces. In the air the accent would be on intercepters and fighter/bombers.

On the subject of atomic weapons General Gruenther said that they would be used to counter aggression. To be a party to atomic warfare would be regrettable, but it was a necessary balancing force when modest numbers were confronted with enemy hordes. "But," continued the General, "ours is a mission of preserving the peace." It was a sad reflection that military strength was needed to prevent aggression and to give political leaders the necessary power to negotiate. General Gruenther said that he could offer no hope that the cold war period would be of short duration, and it was important that some 400 million of our people should be made aware of the issues that were at stake. In conclusion he said that had there been an alliance like that of today in 1939 there would have been no World War 2. He added that supremacy of air power was essential for the defence of Europe.

TEN YEARS AGO the R.A.F.'s first Gloster Meteors went into action against the flying bombs. To mark a decade of continuous service by the type, the Gloster Aircraft Co., Ltd., has presented a painting by Frank Wootton to No. 616 (South Yorkshire) Squadron, Royal Auxiliary Air Force. The picture shows Meteors in action during July 1944, and is here being discussed by Gloster's managing director, Mr. P. G. Crabbe, with S/L. L. H. Casson, D.F.C., A.F.C., and F/L. Barry.

HEADING EAST: As related opposite, a batch of Hunting Percival Provosts destined for the Burma Air Force is now being delivered by pilots of Field Aircraft Services, Ltd. The machines are seen ready at Luton.

THE EMPEROR AT DUXFORD

The R.A.F. Gives of its Best for Haile Selassie

TO Royal Air Force Station Duxford, on October 21st, drove His Imperial Majesty the Emperor of Ethiopia, his second son—His Imperial Highness the Duke of Harar—and members of the Emperor's Ministry and staff. There to receive the Royal party were Mr. George Ward, M.P., Parliamentary Under-Secretary of State for Air (representing the Secretary of State), who introduced Marshal of the Royal Air Force Sir William F. Dickson, Chief of the Air Staff; Air Marshal Sir Dermot A. Boyle, Air Officer Commanding-in-Chief Fighter Command; A.V-M. H. L. Patch, Air Officer Commanding No. 11 Group, Fighter Command; A. Cdre. S. C. Elworthy, Commander, Metropolitan Sector; and G/C. J. Rankin, Commanding Officer, R.A.F. Station Duxford.

Introductions concluded, His Imperial Majesty ascended to a dais to take the salute from an R.A.F. guard of honour, composed partly of Duxford personnel; whereupon F/L. R. J. Spiers, a member of the internationally famous aerobatic flight of No. 64 Squadron, advanced to the dais to declare: "Your Imperial Majesty, the Royal Air Force guard of honour is ready for your inspection, sir"; and the Emperor descended to follow the flight lieutenant along the ranks.

The ceremony over, the Royal party crossed to the airfield. Paraded there for inspection were the beautiful blue Spitfire TE357, maintained at Duxford; Waterbeach's silver Hurricane; examples of the Meteor F.8, Meteor N.F.14, Venom N.F.2, and Vampire T.11; a Swift and Venom of undetermined series, a Hunter F.1 and Canberra B.2. Nearby were the five Meteor 8s of No. 64 Squadron which were later to perform aerobatics for His Majesty's pleasure; and first of these was that generally flown by the station commander, lettered with his initials "J.R.," red-nosed, and with a red cockpit surround. With S/L. H. Bennett, officer commanding No. 64 Squadron, as his guide, the Emperor mounted to inspect the cockpit.

There followed a reception in the officers' mess and luncheon; whereupon the party crossed once more to the airfield, inspected the Aircraft Servicing Flight, and seated themselves in the sunshine to witness a flying display arranged by H.Q. Fighter Command.

First airborne was S/L. D. H. Seaton, of the Central Fighter Establishment, in the Hunter F.1; and this production aircraft having nosed up towards lofty levels for a supersonic demonstration, the Meteors of Nos. 64 and 65 Squadrons (both Duxford-based) advanced on to the scene in magnificent style. They had been arrayed in two parallel lines, facing inwards, with their nose-wheels turned 45 deg respectively to starboard and port. The Derwents were started up and the trolley accs., with their crews, retired to form a rank in the centre. One by one, at 12,000 revs or so, the Meteors blasted their way out of line, turning sharply to starboard, nose to tail. Never have we witnessed such close taxying as when they drew level with the Royal party. As the Meteor leader drew level, his helmeted head turned smartly for "eyes left." Evidently much impressed, His Majesty rose to the salute, which he held until the first complete squadron had passed by. Then the second filed past with the same precision, and with like acknowledgment.

His Imperial Majesty the Emperor of Ethiopia inspects, at Duxford, the cockpit of the station commander's Meteor 8. His guide is S/L. H. Bennett, officer commanding No. 64 Squadron.

The lines of fighters having turned on to the runway they opened up for a stream take-off, and from "rolling" to "last off" all eighteen were airborne in 57 seconds. As they drew out of sight a double-barrelled report sounded a little distance off, and after a lengthy lull (by 1954 Farnborough standards, at least) Hunter F.1 WN911 bore down towards the airfield to hurtle across at a declared 705 m.p.h. Then S/L. Seaton proceeded, in Service parlance, to reef it round, and as the swept wings flicked into the first segment of a hesitation roll, the Emperor shaded his eyes lest he should miss any of the finer points (eight in all) of this faultless manœuvre.

After a rush-past by four Swifts of No. 56 Squadron, Waterbeach (S/L. D. J. Storey)—for which some indeterminate formation had been taken up—the Canberra was ranged for take-off by S/L. R. L. Topp, A.F.C., of the Empire Test Pilots' School. In next to no time he had the glinting black bomber airborne and doing things—such things as low, tight loops, with dramatic Avon-cuts on top; G-squeezing turns, seemingly within a few lengths; and upward rolls into cloud.

Too often it has been our distasteful task to comment unfavourably on solo Canberra presentations by R.A.F. pilots; but this was something very different from anything we had previously seen from the Service. Completely uninhibited, it was well up in the Beamont class—and it would be difficult to bestow higher praise. (One heard that in the previous day's rehearsal, with the cloud base down to 1,800ft, S/L. Topp had looped the Canberra from ground level without losing sight of the ground. Seasoned fighter pilots stood gaping, while less hardened ground crew withdrew precipitously from the scene.)

The zestful Canberra performance having been relished to the full, we saw two Meteor squadrons return to the scene one by one for something extraordinarily snappy in the way of formation breaks. In their succeeding stream landings and taxi-ins the aircraft hung tightly together like beads on two strings of a necklace, and though one of the squadrons was described to us by a member of the other as a bunch of peasants, and by another officer of the same unit as "our auxiliary squadron," both are evidently out of the top drawer and are strictly Regular in every sense.

It fell to 64 Squadron, however, to sign off with their far-

The Emperor, with Mr. George Ward, Parliamentary Under-Secretary of State for Air on the left, and Marshal of the R.A.F. Sir William F. Dickson, Chief of the Air Staff, on the right, regards with admiration the consummate aerobatic performance by five Meteors of No. 64 Squadron.

A smart "break" by Meteor F.8s of the Duxford Wing.

famed aerobatic show, with Sgt. Izzard flying No. 2 to S/L. Bennett, F/L. Spiers as No. 3, F/O. Dick No. 4, and F/O. Heard No. 5. With the sun lowering in a blue autumn sky, clear but for a contrailing B-47 forging up from the south, conditions could hardly have been more favourable, and His Imperial Majesty, we believe, will not soon forget either the setting or the form of this last aerial tribute.

Bristol Also Honoured

ON October 19th the Emperor—with his son, the Duke of Harar—paid a three-hour visit to the works of the Bristol Aeroplane Co., Ltd. Escorted by Mr. C. F. Uwins (aircraft division managing director) and Mr. A. J. Pegg (chief test pilot) he spent a considerable time inspecting the flight-deck and cabin of the first production Britannia.

The royal visitors—who had been received on arrival by Sir G. Stanley White (deputy chairman) and other directors—also inspected Type 171 and 173 helicopters, in which the Emperor showed the greatest interest; this interest became even more apparent after he had seen a Sycamore demonstrated in company with a Freighter, and he asked for full details of the helicopter to be sent to him.

After the flying demonstrations, H.I.M. Haile Selassie was conducted by Dr. S. G. Hooker (chief engineer) through one of the engine test-houses, where he was able to watch an Olympus on test. After lunching with the directors the royal party left by road for Oxford.

Having examined the Hawker Hunter F.1 (later demonstrated to excellent effect by S/L. D. H. Seaton, of the C.F.E.), the Emperor moves on to inspect statically parked aircraft. Attending him is G/C. J. Rankin, D.S.O., D.F.C., commanding officer, R.A.F. Station Duxford. Following, with Air Marshal Sir Dermot A. Boyle, A.O.C-in-C. Fighter Command, is His Imperial Highness the Duke of Harar, second son of His Majesty the Emperor.

THE LORDS DISCUSS HELICOPTERS

BRITISH helicopter development was searchingly examined in the House of Lords last week. Lord Brabazon opened the debate and, after outlining the possibilities of the helicopter, spoke as follows: "If your Lordships look at the situation today you find that not only is America well ahead of us, but she is very active in development and production. I am, and always have been, a great admirer of the British aeroplane industry, but I maintain that on this subject a little more drive and activity is long overdue.

"There are some honourable exceptions. The great firm of Fairey is experimenting with a most revolutionary design which looks as if it might be satisfactory; but it will not be in production until 1960. The great firm of Bristol have done some noble work. They have produced a twin-rotor machine and others, but not even their greatest friends could ever accuse the firm of Bristol of being in a hurry. Westlands are the representatives of Sikorsky in this country. They . . . cannot get an order for the S-56 . . . I think they should be given that order immediately. All other machines of a revolutionary type are more or less gambles. One of our greatest firms is doing nothing at all . . ."

Lord Brabazon went on to point out that the Bell Corporation were selling 60 Model 47s a month and that the total American export of helicopters was already some $500m per year. He added: "Of one thing I am perfectly certain: the modern aeroplane is not the last word. The requirement, first, of a runway a mile long, of 8in concrete, to enable the machine to get up into the air, and the fact that it touches down at over 100 miles an hour just will not do, though it may be all right for the present. How are we to galvanize the industry, and indeed their ally, the Government, to appreciate what is going on in other countries so that we can outstrip them? It is no good for this little country to imitate people . . . We have the talent, but somehow we do not seem to have the will to do it."

In the ensuing discussion, Lord Balfour suggested that each of the British Services should put a little money into a pool for the development and purchase by the Air Ministry of helicopters for all three of them. Lord Brabazon had previously said that Igor Sikorsky "was just about to fail when . . . the Royal Navy went to him and ordered a large number of helicopters, which saved him but which were never received" [owing to their diversion to the U.S.A.]; Lord Sempill recalled that this, the first order ever placed for helicopters, was for 250 Sikorsky R-5s, in 1942.

Replying for the Government, Lord Mancroft stated that the official policy for development followed two lines. The first concerned the geared, hub-drive machine, and one of the most important production orders was for about 100 developments of the Bristol 173, principally for anti-submarine work. Subsequently, it was intended to produce a version of this machine with gas-turbine engines, which "should yield a helicopter with 27 seats, for short stages, or 12 seats for longer stages."

The second line of development concerned aircraft with reactionless rotor systems, aimed particularly at meeting the longer-term demand for faster, simpler, larger and more economical machines. The Fairey Rotodyne, said Lord Mancroft, was a research aircraft; but the characteristics of the first prototype had been so chosen as to fit it quite closely to the 40-seat specification of B.E.A. The M.o.S. had recently ordered a second Rotodyne in order to accelerate this development, and it was hoped that the eventual machine would compete successfully with any other transport, fixed-wing or not, up to stages of at least 100 miles. It was also hoped that it would meet the Army's needs.

Lord Mancroft warned against "putting too many of our . . . financial eggs into the helicopter basket. After all," he said, "there are other developments of at least equal promise on the way—for example, the techniques of blowing air at high speed over the wings or out of the flaps of fixed-wing aircraft." He went on to point out that "on a realistic comparison, the time gap between the Sikorsky S-56 in a tried civil form and our own Rotodyne will not be as large as some people think. A civil version of the Piasecki machine is even further off . . ."

THE COMET INQUIRY

The First Week's Evidence: Pressure-cabin Fatigue Failure In G-ALYP

THE conclusion that the accident to Comet G-ALYP near Elba in January this year was caused by structural failure of the pressure cabin brought about by fatigue was put forward by the Crown in the opening stages of the Comet inquiry in London last week. This conclusion was based on a detailed investigation by the staff of the Royal Aircraft Establishment into all possible causes of the disaster, using evidence from the wreckage, practical tests and theoretical analyses. In the absence of wreckage from the accident to G-ALYY near Naples in April, no definite cause could be suggested, although the same explanation appeared to be applicable.

The inquiry opened in Church House, Westminster, on Tuesday, October 19th, before Lord Cohen, Commissioner, with Sir William Farren, C.B., M.B.E., F.R.S., Professor W. J. Duncan, C.B.E., D.Sc., F.R.S., and A. Cdre. A. H. Wheeler, O.B.E., as his assessors. Sir Lionel Heald, Q.C., Mr. J. P. Graham, Q.C., and Mr. P. J. Stuart Bevan appeared on behalf of H.M. Attorney-General, while the Ministry of Transport and Civil Aviation, the Ministry of Supply, the British Air Line Pilots' Association, British Overseas Airways Corporation, South African Airways, the Air Registration Board, the de Havilland Aircraft Co., Aero Research, Ltd., British Thomson-Houston Co., Ltd., the Navigators and Engineer Officers' Union, Normalair, and the personal representatives of a number of the deceased crew-members and passengers, as interested parties, were represented by counsel. Accredited representatives of the Governments of Italy and of the Union of South Africa were also present, and a watching brief was held on behalf of Union Aéromaritime de Transport.

The explanation of what was believed to have happened to Comet G-ALYP was given to the court by Sir Lionel Heald in his opening for the Crown. (This opening is summarized extensively on pages 652-654 of this issue.) He traced the history of the accidents and of the events which followed them, with particular reference to the technical investigation performed by the R.A.E. The lines of approach and the techniques used were detailed, and also the process of elimination which led to the opinion that metal fatigue was the only possible cause, consistent with all the facts, of the Elba accident.

The first witness to be called was Mr. Eric Newton, chief investigating officer of the Accident Investigation Branch (Civil Aviation), M.T.C.A., who produced formal aircraft documents relating to G-ALYP. Mr. C. M. Mack and Mr. M. R. Ovenden, B.O.A.C. inspectors, then gave evidence in turn, confirming that they had signed the airframe and engines sections respectively on the aircraft's Certificate of Maintenance. The next witness, Mr. A. A. Elliott of the M.T.C.A., stated that all the aircrew licences of the crews concerned in the accident were valid at that time, with the exception of that of the flight engineer, which had expired on December 11th, 1953.

Capt. E. E. Rodley, a Flight Captain of the B.O.A.C. Comet 2 fleet, gave evidence concerning the flight experience of the crew of G-ALYP. Capt. Alan Gibson, he said, "was above average as a pilot and as a commander and had shown himself extremely capable of dealing with any emergencies that might arise." The other crew-members were 1st Off. Bury, R/Off. Macmahon, Flt/Eng. F. C. Macdonald, Steward F. L. Saunders, and Stewardess Jean Evelyn Clark.

The Fleet Engineer Officer, B.O.A.C. Comet fleet, Mr. W. L. Bennett, was the next witness, and he described Eng/Off. Macdonald as competent and conscientious, experienced on Comet aircraft, and having successfully completed a periodical check on all aspects of flight engineering on December 11th, 1953. He continued, "I can see no reason why he should not have renewed his licence at the appropriate date."

Wednesday, October 20th: Second Day.—The picture of what happened to G-ALYP before and after the accident was gradually built up by the spoken evidence of flight crews and ground personnel based at Ciampino, and by the written affidavits of eye-witnesses on the Isle of Elba. Those referring to the Comet and its crew before take-off from Rome pointed to the absence of any prior indication whatsoever of any mishap likely during the flight, while a broken-off R.T. message—and what was seen from Elba—confirmed the suddenness of the disaster.

The first witness to be examined was Capt. A. Meagher, of B.O.A.C., who was in command of Comet YP on its flight from Karachi to Rome on January 9th-10th. He said that the aircraft behaved perfectly normally on the flight, but that it was delayed at Beirut due to an unserviceable port-wing refuelling valve actuator. Two other minor unserviceabilities had arisen, but neither affected the safety of the aircraft. Details of these items were given to Capt. Gibson by the witness on handing over the aircraft at Rome.

Mr. G. C. Stuart, flight engineer on the Karachi-Rome flight of YP, next gave further details of the refuelling actuator's unserviceability. The actuator, he said, was removed, checked and replaced at Beirut following refuelling difficulty, and the fact was entered in the "B snag" section of the Technical Log. At Rome, Flt/Eng. Macdonald—who was taking over for the Rome-London flight—was told of what had happened.

Four affidavits were next read to the court, those of B.E.A. and B.O.A.C. operations personnel who were on duty at Ciampino on the day of the accident. Their statements were to the effect that nothing unusual occurred in the normal preparation for the flight of YP from Rome. This was confirmed by Mr. W. G. T. Latimer (B.E.A. station officer), who supervised the unloading and loading of the Comet, and by Mr. G. A. Bull (B.O.A.C. maintenance engineer), who carried out a refuelling check and departure check on it. Mr. B. J. Folliard (B.O.A.C. assistant inspector of accidents) disclosed that there was a small loading discrepancy of 27 kg between the trim-sheet figures and the total obtained from cargo manifests and passenger sheets, in hold 2A. This, he thought, was an arithmetical error.

The B.E.A. station superintendent at Ciampino, Mr. P. C. Pinfield, was the next witness. He said that the situation as regards access to B.E.A. and B.O.A.C. aircraft by unauthorized persons at the time of the accident was satisfactory, although there had been occasions when members of the public had gained access to the apron area.

R/T. messages to and from the Comet were described to the court by Mr. L. Lippera (B.O.A.C. operations assistant), who on the day of the accident had been on duty, noting such messages in the Flight Progress Log at Ciampino. The messages from YP after its take-off at 0931 included: 0932, "Departed Ciampino heading for Ostia Beacon climbing 2,500ft now"; 0934, "Over Ostia Beacon at 6,500ft climbing"; further messages at 0936 and 0941; 0942, "Abeam Civitavecchia Beacon 19,000ft"; 0946, "Visual flight above clouds at 23,000ft"; 0950, "Over Orbetello Beacon now." At 1005 a background transmission was heard, which might have been either the Comet or Air Traffic Control; no further message from YP was received.

The pilot of the Argonaut G-ALHJ which took off from Rome at 0919 hr that morning, Capt. J. R. Johnson, gave details of his R/T. conversations with the captain of YP, whom he had asked for the cloud-top height. After the Comet had reported over Orbetello, Capt. Johnson said, "Immediately his transmission stopped I called Rome Control. . . . This call to Rome must have reminded the captain of YP that he had promised to give me the top of the cloud, and he called: 'George How Jig from George Yoke Peter. Did you get my—" and the transmission stopped at 'my.'"

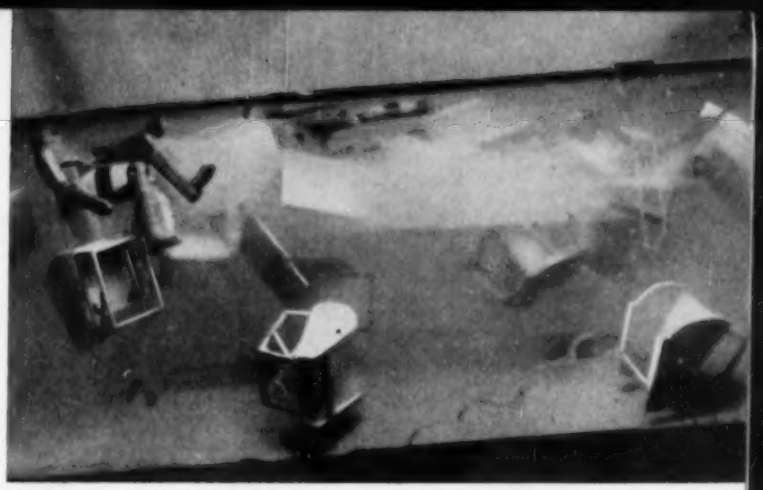
An estimated position of G-ALYP at 0951 was given by Mr. C. Evans (until recently B.O.A.C. Fleet Navigation Officer, Comet Fleet), who said that the Comet was just about crossing the coast on its way from Orbetello to Elba at that time. Its height, he thought, would be approaching 27,000ft. This was followed by an account of the meteorological aspects of the accident by Mr. P. J. Meade, senior meteorological officer at London Airport, who reported that there was no evidence of severe turbulence being encountered, although the Comet was flying in an area in which, due to the relative position of a northerly jet stream, severe turbulence was a possibility.

The events at Elba at the time of the accident were next outlined, by means of affidavits by eye-witnesses. Extracts from these include:—

Ninuccio Geri: "I am a sailor . . . I was busy working when I suddenly heard a heavy roaring noise like thunder. I turned in the direction of the noise and saw a globe of fire rotating as it came down into the sea. . . ."

Vasco Nomellini: "I am a farmer . . . I heard the noise of an aircraft . . . but I did not pay any attention to it. Suddenly, however, my attention was caught by a roaring sound in the air in the direction from which the noise of the aircraft was coming, and I distinctly noticed, in that direction, two pieces of an aircraft, the smaller in flames, falling in almost parallel lines into the sea. . . ."

Probable source of the pressure-cabin failure on G-ALYP was traced, among the recovered wreckage, to this corner of the rear A.D.F. window, where signs of high-level fatigue were found.



The aft interior of the R.A.E. Comet cabin model, 0.22 sec after decompression. This corresponds to about 0.7 sec full-scale.

Leopoldo Lorenzini: "I am a driver . . . I suddenly heard a number of explosions and a great roaring noise. I turned in the direction from which the noise was coming and saw a red flame falling into the sea, followed by a wake of smoke in the form of a spiral. . . ."

The final affidavits were those of Lt. Col. Guiseppe Lombardi, officer commanding the Harbour Authority, Porteferraio, Elba, who described his action in arranging for immediate search and rescue operations by both aircraft and shipping, and of Luigi Papi, one of the fishermen who took part in the search.

Thursday, October 21st: Third Day.—The evidence of Sir Arnold Hall, Director of the Royal Aircraft Establishment, concerning the Establishment's comprehensive and thorough investigations into the Comet accidents, was the main feature of this day's proceedings, amplifying the outline given by Sir Lionel Heald on the opening day. In addition, details were given of the Royal Navy's search for wreckage of G-ALYP, and of the available medical evidence.

A full account of the preparation for the naval search and salvage operation off Elba for G-ALYP, and of the results obtained, was given by Cdr. C. G. Forsberg, R.N. [see *Flight*, October 1st, 1954]. Professor Antonio Fornari, of the Institute of Forensic Medicine at Pisa University, who examined the bodies of 15 of the victims of the Elba accident, was next witness. Speaking through an interpreter, and referring to a report of his findings already published, he said that he found no evidence that the bodies had been subject to any kind of explosion inside the cabin, such as that caused by a bomb, nor had drowning been the cause of death. He considered that the causes of death were violent displacement of the bodies and sudden impact with parts of the aircraft, explosive decompression, and deceleration.

Dr. R. D. Teare, a Harley Street pathologist, said he had seen Professor Fornari's report, and commented, "I think his observations have been entirely accurate and that the deductions are correct." The burning or scalding of the bodies, he thought, occurred after death, probably through the presence of burning kerosine on the water.

Sir Arnold Hall was the next witness. Explaining the R.A.E. approach in the early stages of its Comet investigations, he said, "We clearly wished to satisfy ourselves on the structural integrity of the aeroplane and therefore initiated certain tests on the cabin, tail, and reviewed certain other tests done by the de Havilland Company on other parts of the aircraft. We clearly also wanted to satisfy ourselves about the possibility of explosion in the pressure cabin due to either ignition, for example, of hydraulic fluid, or any other cause. We wanted to satisfy ourselves about the possibility of explosion in the fuel tanks. We needed to satisfy ourselves about any possibilities of loss of control due to either aerodynamic cause or other cause. We wished, of course, to satisfy ourselves about the cause of any particular phenomenon we noticed on the wreckage as it came in, and that involved a great deal of metallurgical, chemical and physical testing of parts as they were produced."

The sources of information, Sir Arnold said, apart from the wreckage, included Comet G-ALYU which was subjected to fatigue tests, and Comet G-ANAV which was used for flight tests. "Those flight tests in our mind at the beginning were particularly concerned with the possibilities of vibration and flutter, though the aircraft was used subsequently for certain aerodynamic tests and fuel venting tests. . . . We operated it at all times in company with a Canberra aircraft which flew behind it in order to keep general observation on it."

The Establishment's report on the Comet investigations, which was before the court, was an account of the results of all the lines of inquiry which had been pursued. The amount of the wreckage which had been recovered (the diagram shown by Sir Arnold to the court is reproduced on page 653) was most useful in checking the original theoretical approaches. Several photographs in the report illustrated the reconstruction of the wreckage—the building-up of the "jig-saw."

Following an early examination of the wreckage, Sir Arnold said, "We first formed the impression that the aircraft broke up probably into about six main pieces. There is the nose of the fuselage, the after end of the fuselage, the centre section containing the power plant, the starboard wing-tip and the port wing-tip and the top of the centre of the fuselage. That was a preliminary judgment, and lined up with the impact damage and also lined up with the plot of the wreckage on the bed of the sea."

The sequence in which this break-up took place, already given by Sir Lionel Heald (page 652), was then detailed by Sir Arnold. He went on to give a few examples of the clues which together pointed to this sequence: paint-scratches along the wing as far as the aileron, indication of downward bending at the wing break-points, fire damage on the centre-section only, and different types of control-cable breakage. Confirmatory evidence that the violent pressure-cabin disruption came first was given by the failure of particular electrical circuits and by the appearance of the passenger seats, which had failed in a forward direction (towards the source of the cabin failure) and subsequently backwards (on hitting the sea).

The source of the pressure-cabin failure was a point near the rear A.D.F. window: fracture analysis showed that all fractures in the fuselage in this area ran away from this point, and none ran into that area. On the actual piece of top-fuselage wreckage, on view in the court, Sir Arnold pointed out also a large compression buckle. A similar compression buckle and fracture, but occurring at the forward port passenger window, was next shown to the court on part of the fuselage of Comet YU, which had been the subject of tests at Farnborough.

Sir Lionel Heald: Is it fair to say that there is a very close correspondence between those two fractures?—Yes, I think that is correct.

The time of descent, from the extent of fire damage, appeared to be about three minutes, implying that the height of the aircraft was 25-30,000ft. Tests with dynamically similar models had given an approximate time of descent, in the broken-up state assumed, of 2½ minutes, and had given a wreckage pattern similar to that found on the sea-bed. The medical evidence also, Sir Arnold thought, was consistent with a breach of the fuselage.

Another section of the Farnborough report described tests on a one-tenth scale Perspex model of a Comet cabin, fitted with seats and dummy passengers (scaled to the correct size and strength as accurately as possible). This had been placed in a pressure chamber evacuated in effect to 40,000ft, with the cabin at 8½ lb/sq in differential pressure, and had been caused to burst near the point at which Comet YP was believed to have failed. A number of photographs (example above) showed the effect of the sudden decompression: after the equivalent of 0.03 sec, the seat-backs in the aft end of the cabin were moving forward; after 0.1 sec, complete chaos had developed; after 0.7 sec, seats were flying about in all directions and one dummy passenger was hitting the roof with considerable violence. Although the timing could not be considered exact, these pictures gave a qualitative idea of what probably happened and again gave agreement with conclusions from all other sources.

Having concluded that the occasion of the Elba accident was a failure of the pressure cabin at the rear A.D.F. window, a number of possible causes had been considered, in turn, Sir Arnold said, before what he believed to be clear evidence was found on G-ALYP.

Sir Lionel Heald: Can you say that in spite of the most careful examination you have been able to find no evidence of a deliberate explosion anywhere in the wreckage?—That is so, yes.

Concerning a possible accidental explosion, Sir Arnold said that although electrical and hydraulic components were together located in the equipment bay, they did not constitute an obvious hazard, and such an explosion would not in any event produce the results actually found. An explosion due to hydraulic mist, or in the fuel tanks, was also unlikely. Only continued and extreme negligence by the flight engineer in his control of the pressurization could cause abnormally high cabin pressure leading to an explosion and this possibility, too, was discounted.

Also discounted after thorough investigation as the cause of the cabin failure were abnormally high tail-loads produced by failure of the auto-pilot or the power-operated control system; in addition, the tailplane itself was shown to be structurally sound. Over-control by the pilot was possible, but improbable under normal gust conditions; dangerously abnormal gusts in this particular case were themselves extremely improbable.

Two other factors were discovered during the R.A.E. investigations; neither was apparently a cause of the Elba accident but they were mentioned in the report. The first was that it was possible for fuel escaping from the underwing vents to reach a position less than one inch from the jet-pipe shrouds. This had been traced using radio-active fuel and Geiger counters. As a normal shroud temperature was 350 deg C and the minimum ignition temperature of kerosine was 250 deg C, this was "slightly worrying," although the ventilation at that position was high.

It had also been found that there was a possibility of the integral wing tanks being damaged during pressure-refuelling "on remote occasions." It had been established however, that even if the tanks were damaged the loss of strength to the aeroplane was relatively little.

Friday, October 22nd: Fourth Day.—Most of the day was taken up with discussions on fatigue, to which the cabin failure of YP was attributed. Sir Arnold Hall and Dr. P. B. Walker, head of the Aircraft Structures department at Farnborough, both gave evidence. The existence of cracks in G-ALYP, formed during manufacture and drilled to prevent their propagation, was revealed.

Sir Arnold Hall first gave his conclusion that the probable cause of the primary failure in the pressure cabin was "a phenomenon known as fatigue." "The essence of the phenomenon," he said, "is that whereas the structure will stand one application of the load quite satisfactorily, it may not stand many hundreds, thousands or millions of applications of the load satisfactorily, and may in the end fail under a load which it is well capable of bearing when new. . . ."

Sir Lionel Heald: Could you enlarge just a little on the point how far it is possible to know what is going on prior to the failure actually taking place?—So far as I am aware it is not possible to know what is going on. I know of no physical test one can apply to a piece of material which will tell one how much it is fatigued. . . .

(*To be continued*)

(*Sir Lionel Heald's opening: page 652*)

INDEPENDENT SUSPENSION: London motorists immured in Motor Show Week traffic-jams must have wished that something like this could, magically, happen to their vehicles. The 750 c.c. Renault (weight, 1,235 lb) is being borne high above the Seine by a Sabena Sikorsky S-55.

HERE AND THERE

Otters for U.S. Army?

MR. T. E. STEPHENSON, director of the aircraft division of Canada's Department of Defence Production, said recently that an order was expected from the United States Army for a small number of D.H.C. Otters on a "trial" basis. (The Otter was evaluated, in company with American types which included helicopters, at Fort Bragg, North Carolina, early this year. The R.C.A.F. equipped its No. 408 Squadron, a photo-reconnaissance unit, with 20 Otters last March, and the R.C.A.F. has 20 more on order. D.H.C. Beavers are already in service with the United States Army and Air Force.

Change of Scene

AS recently reported in these columns, the two Austers of Pest Control, Ltd., which carried out successful spraying operations over the pine forests of the Moray Firth are now engaged on a cotton-spraying operation in the Sudan. Their pilots have lately been joined there by four more of the company's pilots—R. C. Young, Jack Akers, Gordon Brown, and Colin Veitch—who are beginning a new war on locust swarms.

Models in Malta

IN Malta, G.C., is a thriving model aeroplane club. A correspondent who was recently on holiday there visited its club-rooms at Sliema and learned that it was officially opened last July by S/L. Eric Cable of R.A.F. Station Luqa, who until his posting to Malta was president of the R.A.F. Model Aircraft Association. A marine-aircraft section of the club launches its flying-boats, seaplanes and radio-controlled motor-boats in Sliema Bay. Our informant remarks that the members—and, indeed, young men in all parts of Malta—show great interest in aviation, and he feels that the Air Ministry is missing an opportunity by not harnessing this enthusiasm by forming a George Cross Island Squadron of the Air Training Corps.

A Phœnix Arising

WEST German Radio reported last week that Prof. Kurt Tank, the famous "Fw" aircraft designer, had arrived in Hanover from Argentina, where he has been heading a team of some 70 German aircraft designers working for the Argentine Government. Interviewed on his arrival, Prof. Tank expressed the view that it would take West Germany at least three years to build up a tactical air force with modern aircraft. It is also reported from Germany that on October 18th the foundation stone was laid for the first building of the West German aircraft research station in Mülheim. It was rumoured that Prof. Tank may be appointed director of the station.

Loss of a Javelin

DURING a routine test flight from Gloster's airfield at Moreton Valence on Thursday last week a Javelin piloted by F/L. R. J. Ross (a Service pilot attached to the company) got into difficulties and came down in the Bristol Channel. Rescue launches recovered some wreckage, which was landed at Avonmouth and taken to Hucclecote. Although the pilot, who was alone in the aircraft, is reported to have baled out, no trace of him was subsequently found. He had previously been at the R.A.E., test-flying Comet G-ANAV.

The Army Climbs

AN unofficial helicopter altitude record of 24,500ft is claimed by the U.S. Army. The machine concerned is the new Sikorsky XH-39 which, with the same pilot, W/O. W. Western, recently gained the as-yet unconfirmed speed record of 156.005 m.p.h.

Saabs for Ethiopia

FOLLOWING the delivery of a number of Saab 91B trainers to the Imperial Ethiopian Air Force earlier this year, an additional order has been placed with the Swedish manufacturers.

Car Show in Retrospect

ON sale today (October 29th) is the special Show Review Number of *The Autocar;* contents include a technical survey of design trends as seen at the Motor Show and an appreciation of the cars from a woman's point of view.

IN THE G.C. ISLAND: Part of the club premises of the Sliema Model Aeroplane Club, situated in the house of the founder, Mr. J. Axisa (see paragraph above).

Canberra B8 'Night Intruder'

The Canberra B 8 is the most versatile of the Canberra series. It can readily be converted to perform a number of roles, including night intrusion, high altitude bombing and target marking. In its Night Intruder role it carries underwing armament and forward-firing cannon in the bomb bay. The offset fighter-type canopy gives the pilot a superb all-round view and the redesigned navigator's compartment provides better vision and a wider range of navigational aids.

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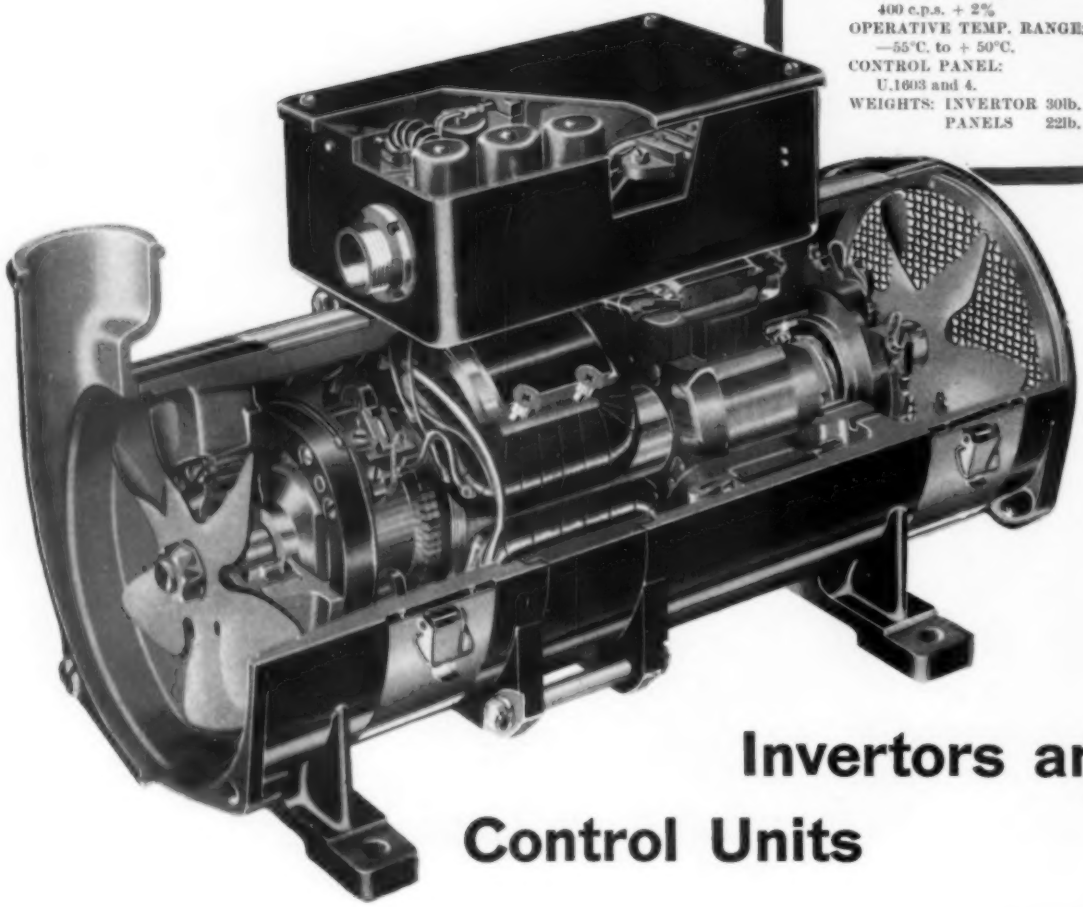

Invertors and Control Units

ROTAX manufacture a wide range of invertors for all forms of aircraft applications. These invertors, used in conjunction with control panels which incorporate a tuned frequency detector, balanced voltage bridge and magnetic amplifiers, maintain an almost constant voltage and frequency output, irrespective of load and input voltage variations. Both units are extremely robust and are fully suppressed. Using additional control equipment transient overloads of 100% can be handled quite satisfactorily. Full information available.

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REHEAT for TURBOJETS

Five Years' Progress Reviewed in an R.Ae.S. Lecture

LAST week a main lecture of the Royal Aeronautical Society was read before the Society by Mr. J. L. Edwards, A.F.R.Ae.S., chief combustion research engineer of the de Havilland Engine Co., Ltd. He had previously delivered a section lecture to the Society in 1949, and the present paper outlined the work done in the five years since that date.

When his first paper was prepared, said the lecturer, reheat was in its infancy in Great Britain. Sketchy information was being obtained from the United States and preliminary data had been obtained from the National Gas Turbine Establishment, but the majority of the problems which were now being met were then completely unknown or were considered unimportant. His original paper was therefore largely theoretical.

The modern applications of reheat were to assist the take-off of bombers and to boost the maximum speeds of fighters. In the former case only the sea-level condition was applicable, and test-bed results were therefore representative; in the case of the fighter, ram compression raised the pressures and temperatures in the tail-pipe so that, even at altitude, these values were not greatly different from those which could be simulated on the ground. It was more difficult, however, to examine the condition which occurred when full thrust boost was suddenly applied to a subsonic aircraft flying at extreme altitude. The lecturer went on to explain some of the fundamental factors governing the use of reheat, and pointed out that a turbojet with a mass flow of 250 lb/sec at sea level might require a reheat fuel flow of as much as 10,000 gal/hr at Mach 1.5.

The first main section of the lecture dealt with performance. It was perhaps not generally appreciated that the Mach Number of the gas flow in the tail-pipe was of vital importance, since not only did it influence the maximum available reheat boost, but also had a marked effect on mechanical design and weight. Mr. Edwards showed a number of curves (Fig. 1) obtained over the past few years on nine de Havilland turbojets showing the agreement with theoretical results and underlining the manner in which the losses increased as the temperature ratio rose.

Flight performance had proved exceedingly difficult to measure, despite comprehensive instrumentation. The aircraft used by the lecturer's company were a Vampire with a long tail-pipe and fixed nozzle employed on performance measurements up to a boost of 25 per cent, and a Venom with a short tail-pipe used on problems relating to nozzle area and fuel control. The determination of stability limits on the Vampire was laborious. Early tests with 25 per cent boost were disappointing, the aircraft climbing adequately at 8,000ft when violent instability set in followed by extinction of the reheat flame. This occurred with an installation identical to one which had been used successfully up to 50,000ft with the exception of slight differences to the flame stabilizer and the fuel-injector drillings. Fuel was supplied from a circular distributor co-axial with the stabilizer and, to provide higher boosts, fuel jet sizes had been increased without materially increasing supply pressure. Some of the fuel was directed to impact on the back of the gutter (providing a pilot flow) and the rest was sprayed from the same ring at right-angles to the gas flow. Further examination showed that the piloting jets were supplying excessive fuel and a series of flights with various propelling nozzles enabled Fig. 2 to be drawn. This compared the reheat burner pressures at which extinction occurred with those actually required, and it could be seen that the curves intersected at 8,000ft. Reduction of the pilot flow at once permitted flights to 44,000ft altitude.

A considerable amount of additional work was then required in order to overcome high-temperature troubles within the rear cone fairing of the aircraft which had caused blistering of the paint and deterioration of electric cables. Proper venting and lagging effected a cure and illustrated the manner in which troubles could arise if adequate precautions to provide good thermal insulation and venting were not taken.

The requirements of modern military aircraft were very severe, visualizing Mach Numbers of the order of 1.5 at sea level and up to 3 at altitude. In such aircraft the bulk of the thrust came from the reheat system, the turbojet being relegated to a subsidiary position and using the afterburner as a ramjet. In supersonic flight the importance of the intake design was very great, and the problems involved in the design of the whole power plant were enormous; there appeared to be only one alleviating factor, namely, that, assuming constant turbine inlet temperature and efficiency, the temperature ratio across the turbine—and hence the exit Mach Number—were unaffected by changes in the flight conditions. At a Mach Number of about 3, ram pressure and turbine outlet pressure became roughly equal, and the lecturer considered that this might be the criterion which discriminated between the two forms of prime mover.

High-speed flight at high altitudes did not appear to offer considerable combustion problems but if pressures were allowed to drop to about 5 lb/sq in absolute, as might obtain when cruising without reheat, combustion might be difficult if not precarious. Any sudden application of reheat in such a condition implied a very wide stability range. Fortunately the position was not as bad as might be expected, and de Havillands had, with the Venom, achieved relights at 40,000ft. Careful design of the fuel injection equipment was important, and special attention had to be paid to the air/fuel ratio and distribution just before light-up, and to the time of the ignition, initial fuel injection and opening of the propelling nozzle.

At high forward speeds, the effect of intake drag became considerable and the net thrust increase due to reheat rose; for example, in one configuration, the proportionate thrust increase rose from 40 per cent at sea-level static to 215 per cent at Mach 3.

The next main section of Mr. Edwards' paper was headed "general design requirements." It was postulated that in any given installation the need for performance called for the attainment of the maximum possible thrust which, in turn, demanded the highest possible temperature. This value, of about 2,250 deg K, could

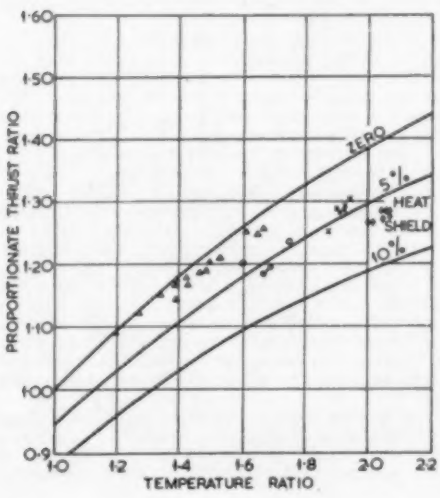


Fig. 1. Correlation of numerous test results with three theoretical curves for zero, five and ten per cent loss, all for a tail-pipe Mach number of 0.27. The loss percentages are additional to those present without reheat.

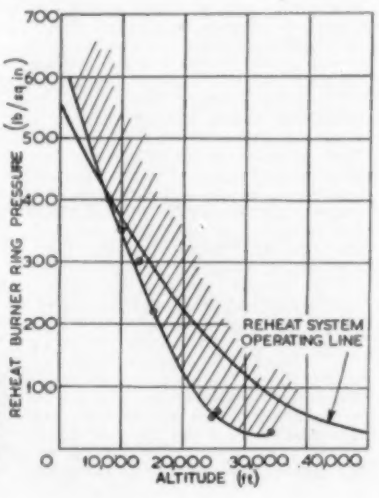


Fig. 2. A typical stability curve determined from flight testing. Reheat combustion is not possible in the shaded region, and the reheat operating line is such that—as actually happened—the reheat fails at 8,000ft.

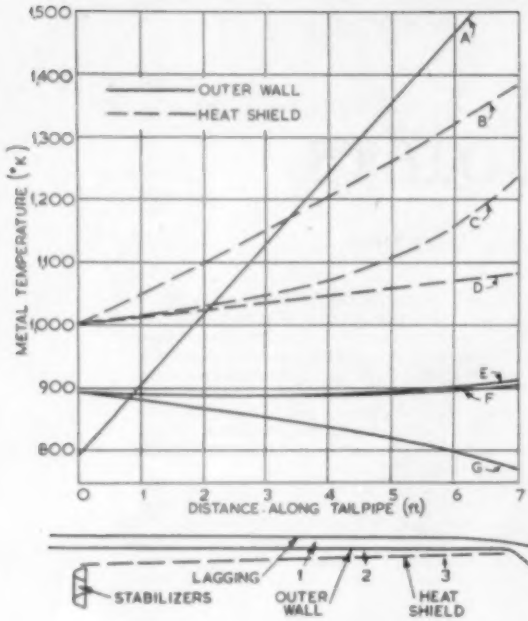


Fig. 3. Temperatures in the tail-pipe outer wall and heat shield. A gas entry temperature of 1,000 deg K is assumed, as is a reheat temperature of 2,000 deg K and a cooling-air entry temperature of 300 deg K. The mass flow is divided so that 85 per cent flows along "3," 10 in "2" and 5 in "1"; when the heat shield is perforated, 70 per cent of the "2" flow bleeds into "3," the space "2" being tapered to keep a constant mass flow per unit area of section.

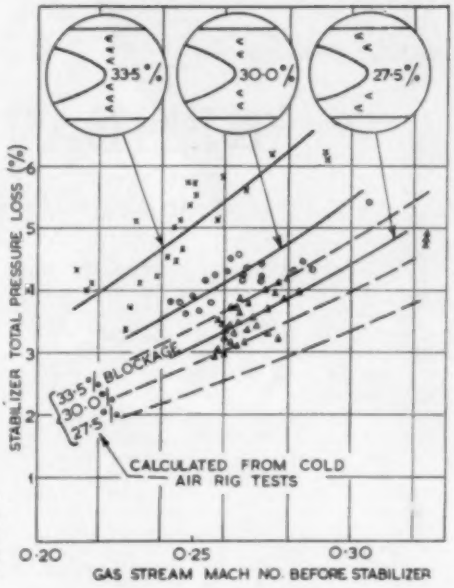


Fig. 4. Correlation between gutter loss characteristics and engine test results; the broken curves are the results of cold tests. The three inset diagrams show stabilizer geometries.

REHEAT FOR TURBOJETS . . .

be reached only with a stoichiometric reheat mixture burnt with 100 per cent efficiency and without any cooling of the afterburner. In practice, a tail-pipe temperature ratio of about 2.0 seemed the highest that could be realized, and this was worth while only if the flow Mach number were kept well below 0.3.

To prevent metal temperatures from rising to about 1,000 deg F it was essential to employ a heat shield within the afterburner. This had to be so arranged that the space between it and the outer wall was always filled by a flow of cold air, and never by a combustible mixture. The liner had to be carefully suspended by flexible or hinged strips which had to be capable of holding it both in place and roughly in shape. Ceramics, thought Mr. Edwards, had a rather limited application, and were useful principally in permitting thinner sections to be used; they did not allow the use of inferior materials.

In the design of flame-stabilizers, care had to be taken to preserve freedom of movement and to choose a material section adequate for the job. Fuel galleries, also, had to be carefully designed to avoid leaks yet permit limited relative movement. It was essential to keep the system dry externally as otherwise a serious fire risk might occur following shut-down. Serious damage could be caused by fuel dripping on to the hot tail-pipe and igniting in the absence of any cooling airflow; it was, therefore, desirable to shut off all the fuel pipes and galleries, and this had the further advantage of obviating blockages which might follow cracking of the fuel within the hot pipes.

One detail point often overlooked was that it was essential to streamline all fairings, supports, and even bolt-heads, situated in the combustion zone, since these could otherwise act as stabilizers for attached flames. If the latter occurred, oxidation became rapid and failure inevitable.

Attention was then turned to the design of diffusers (the expanding portion of pipe between the turbojet and the reheat combustion zone in which velocity is reduced and gas pressure increased). Complete diffusion was, of course, impossible, and it was normal for reheat combustion to take place in a flow velocity of 400 to 600 ft/sec, and a Mach number of around 0.2. The optimum diffuser was not readily attainable, and considerable research was necessary on all kinds of test rigs. One point worth noting was that it was common for the flow near the outer wall of the tail-pipe to have a higher velocity than that near the centre. This resulted in a reduced combustion efficiency and higher drag for stabilizers mounted in the region of increased velocity. It was common to use the end of the engine tailcone as a flame stabilizer (particularly on low-boost applications) to give a core of flame and to keep heat away from the skin. If the distribution were very bad there might be such a low velocity in this region that combustion would be quite inadequate.

Fuel injection was next examined, and it was shown that, by merely injecting neat fuel at 90 deg to the gas flow it was possible to obtain a blast atomization to a maximum droplet size of about eight microns. Before burning, however, the fuel spray had to be vapourized and, assuming a vapourization time of half a microsecond (for a 10 micron droplet) each particle would travel about 4in during vapourization in a flow of 600 ft/sec. In practice, it was preferable to position the stabilizers rather more than 4in downstream from the injection nozzles.

The lecturer then quoted some hypothetical figures based on the large turbojet previously mentioned. On the test bed, a final reheat temperature of 1,750 deg K would be achieved with an overall fuel/air ratio of 0.0385, of which the engine mixture ratio would be 0.0179. These ratios increased to 0.0428 and 0.0182 making allowance for combustion efficiencies of 98 per cent (engine) and 85 per cent (reheat); in bulk terms, 2,050 gal/hr would be burnt by the engine and 2,760 by the afterburner.

The most adverse flight condition occurred during light-up at extreme altitude, when tail-pipe pressure was low, mass flow at a minimum and, probably, temperature also low owing to premature opening of the propelling nozzle. In the hypothetical example, Mach 0.9 at 60,000ft would result in a mass flow of only 35 lb/sec, in which 470 gal/hr could give the 1,750 deg K reheat temperature with a combustion efficiency of 70 per cent. This implied a fuel flow range of nearly six to one, and—assuming a simplex system—a fuel-pressure range of 36 : 1. Experiments indicated that 10 lb/sq in was the lowest supply pressure for reasonable combustion at an altitude of 50,000ft and, on the above basis, a sea-level static pressure of 360 lb/sq in was required, rising to 920 lb/sq in at sonic speed. The lecturer went on to determine the optimum form of injection system for such an engine.

In practice, the injection system supplied a number of bands of fuel/air mixture each of which fed a particular part of the stabilizer. Two main forms of injector were used: radial spray bars injecting fuel tangential to circles co-axial with the engine, and spray rings injecting radially inwards or outwards. It was felt that the ring distributor was probably preferable, although a combination of both was good where injection rates were considerable.

In Mr. Edwards' opinion, the concept of injecting upstream of the turbine was fundamentally wrong. It assumed that gas temperatures would always be sufficiently high to maintain combustion, that no fuel would burn during passage through the turbine blading and that stability would be unimpaired with changing flight conditions. The only realistic application was that of an engine with a single-stage turbine in which appreciable overheating of the basic engine was permitted.

Experience had shown that, of the many forms of stabilizer (or flame-holder) available, the simple circular gutter grid was as good as any. The aerodynamics of such systems were generally understood but the actual combustion process was not. The results of a number of actual tests were given (Fig. 4) and these were found to be generally about one per cent higher than detail tests predicted. The discrepancy was probably owed to the fact that the test figures ignored a number of allowances.

Regarding actual combustion, it was shown that the eddy region immediately behind each part of the stabilizer was of fundamental importance. If the flow in this region became disrupted or if the mixture became too weak or rich then insufficient heat would be generated in the initial combustion to propagate the flame, and extinction would occur. The basic criteria of stabilizers were then examined and it was the author's opinion that the information most badly needed was the rate of temperature rise and the rate of spread of the flame for various velocities and fuel/air ratios. Mention was made at this point of the possibility of cutting the point off the engine tail-cone to form a simple region of eddy reversal.

Turning next to ignition, it was considered that, although direct ignition by high-tension or high-energy spark was possible, a simpler solution was "streak" ignition, in which a plain jet of fuel was injected upstream of the turbine. Provided the turbine

Fig. 5. A very short reheat tail-pipe and clamshell two-position propelling nozzle. This was tested on a Ghost-Venom.

entry temperature was sufficiently high, the streak ignited and lit up the main reheat system. Unfortunately, this arrangement might be difficult to employ with later turbojets with multiple turbine stages, where excessive cooling and dispersion of the flow might cause the streak to be extinguished or broken up.

One of the most persistent troubles in the development of reheat was a phenomenon called "screech." This was a high-frequency vibration of peculiar violence, characterized by the tearing of sheet metal, breaking of bolts and similar mechanical failures. It seemed clear that it was caused by a longitudinal or transverse vibration of the exhaust flow; the amplitude could be great and pressure variations exceeding ±7 lb/sq in had been found in Goblin and Ghost installations. It was not thought that the metal of the tail-pipe was resonant; failures were, therefore, due to forced vibration.

Measurements had shown pressure pulsations in the tail-pipe with frequencies from 60 to 1,200 cyc/sec, and it seemed probable that the vibration causing screech was of a transverse nature. The mechanism of excitement seemed to parallel that of rich-extinction instability: a local pulsation altered the surrounding fuel/air ratio, which altered the heat supply and sent back a pressure wave which was reflected back to make the process self-supporting. Alternatively it might be that radiation from the reheat flame was causing early ignition so that the flame could fluctuate between its normal position and a second, unstable position, slightly upstream.

The closing sections of Mr. Edwards' paper dealt with propelling nozzles and fuel systems. Of the former, two de Havilland nozzles were cited: a square-section nozzle run with 20 per cent augmentation, and a clamshell two-position nozzle (Fig. 5) used with success on a Venom. It was agreed, however, that the fully variable nozzle was essential, and Mr. Edwards thought that there was no easy way out; in fact, he said, "the complicated mechanisms at present coming on to the test bed may be the only answer." One of the principal fuel-system troubles was control of the reheat fuel pump so that the enormous flows required could be obtained and without danger of the pump over-speeding should the fuel supply fail. It was suggested that an air-turbine, fed on compressor-bleed air, would make such a pump virtually self-governing.

REHEAT: A POSTSCRIPT

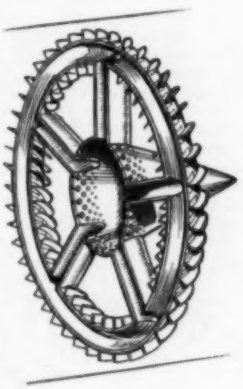
IN the lecture summarized above, Mr. Edwards naturally confined himself largely to work undertaken by his own company. At present, the only British engine with reheat actually in service is a variant of the Rolls-Royce Avon, which is used in large numbers as the power unit of the Supermarine Swift Mk 3 and 4.

Examples of both these aircraft could be inspected at the last S.B.A.C. Show at Farnborough, and a *Flight* artist drew two sketches—reproduced on this page—by looking into the tail-pipes of these aircraft. They show the type of flame-holding equipment which is proving acceptable for service in the Swift at reheat thrusts of the order of 9,500 or 10,000 lb.

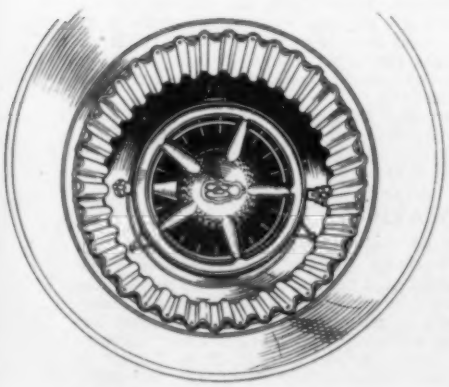
As can be seen, both employ a central cone, pointing upstream, in which numerous rows of holes are drilled to promote turbulence, the hole size increasing to a maximum around the trailing edge of the cone. From the cone, five radial gutters lead to an annular gutter mounted quite close to the inner wall of the jet-pipe itself, and held in position by three hinged supports. In the sketch of the Swift F.4 installation, the fuel-injection bars can be seen, and they appear as an array of white radial lines projecting inwards from a circumferential ring. This drawing also shows the heat shield mounted around the inner wall of the tail-pipe.

A point of particular interest is that, whereas the annular flame-holder used on the Swift 4 is a simple sheet assembly, that of the Swift 3 is provided with numerous vanes evidently intended to produce a tremendous swirl downstream of the flame-holder. Both these installations use a propelling nozzle with left- and right-hand eyelids each actuated by a pair of Dunlop pneumatic rams. The eyelid movement is rapid, and variation in thrust is, in the Swift, accompanied by spillage of fuel from a vent pipe under the rear fuselage.

During a recent demonstration at South Marston we were able to be present during a ground run-up to full reheat thrust, after which the Avon was shut down completely. Looking up the jet pipe it was apparent that kerosine was still burning from the reheat nozzles, there being a licking tongue of yellow flame from each injector. Gravity feed of surplus fuel was indicated by the fact that the flames were most prominent (about 4in long) around the lower part of the injection assembly. This gentle combustion continued for several minutes, accompanied by a hazy exhaust from the propelling nozzle. The engine was then re-started, and the first few seconds of cranking snuffed the flames out, and the Avon started normally.



This sketch shows the type of flame-holder, or stabilizer assembly, employed on the Rolls-Royce Avon of the Swift F.3.



By looking directly up the "spout" of the Swift F.4 one may obtain a view similar to that shown here. The actual two-position propelling nozzle is not shown. This installation appeared to have no swirl vanes. Both the installations seen at Farnborough had done considerable running but appeared to be in perfect condition.

NUCLEAR-POWERED AIRCRAFT

OVER £10m has been allocated to the establishment of a new laboratory, to be known as the Hartford (Connecticut) Research Facility, which is being built by the U.S.A.F. in conjunction with Pratt and Whitney Aircraft. The laboratory will be devoted to aircraft power-plant research, and it is expected that most, or all, of the effort will be directed towards the development of a nuclear-reactor aircraft power unit. Pratt and Whitney (whose headquarters are at Hartford) have been working on this problem for three years, in conjunction with Boeing; other atomic-engine projects are in the hands of General Electric (with Convair), Lockheed and North American, the latter company concentrating on sodium-cooled reactors. Present opinion indicates that the U.S.A.F. will have a nuclear-powered prototype flying surprisingly soon—perhaps in about five years' time.

Helicopter Gas Turbines Discussed

Views on Mr. John Brown's Association Lecture

SOME informative comments were made in the course of the discussion which followed Mr. John Brown's paper on *Applications of Gas Turbines to Helicopter Propulsion* presented to the Helicopter Association of Great Britain on October 15th. A digest of the lecture appeared in last week's issue of *Flight*, and the discussion is summarized below.

MR. F. R. BELL (Blackburn and General Aircraft) was in complete agreement with most of the conclusions reached by Mr. Brown as a result of his investigations. One point which he did make, however, concerned twin-engine reliability: a variable tip-jet nozzle would be necessary, in order to permit the nozzle area to be reduced proportionately when only one engine was in use.

MR. J. TUSTANOWSKI (Percival Aircraft) congratulated the lecturer on a paper of outstanding merit and added that the factors which were decisive as far as endurance was concerned were disposable load, fuel consumption and aerodynamic cleanliness. The assessment of the shaft-drive and ducted-gas schemes had to be made on a balance of these three items and, since no developed turbine helicopters were flying, the question would remain controversial for some time. The specific fuel-consumption ratio (ducted gas to shaft drive) was approximately 1.40:1. This might have suggested a doubtful case for the ducted-gas scheme but, according to his calculations, he thought the "break-even" endurance would be nearer to two hours as opposed to the author's estimate of one hour.

MR. J. SHAPIRO (consultant) said that he had heard reports from the U.S.A. to the effect that the free turbine (shaft-drive) did not give the most efficient results and that by using instruments to govern a solid or coupled turbine (also shaft-drive) a better combination could be achieved. Another important point to be taken into consideration in design studies was the question of operation under adverse climatic conditions, because in high ambient air temperatures all turbines responded badly.

MR. A. MCCLEMENTS (Ministry of Supply) agreeed with Mr. Tustanowski that the aerodynamic considerations had an important bearing on endurance and thought that the rotor-drag figure used by the lecturer in his calculations was rather pessimistic. Any diminution of the drag figure made the results of the calculations lean more towards the figure of two hours endurance quoted by Mr. Tustanowski.

MR. N. E. ROWE (Blackburn and General Aircraft) thought that, in view of the marked decrease in specific fuel-consumption with increasing blade-tip Mach number, the value of the paper would be considerably enhanced if its scope could be extended to include the higher tip-speeds. On the question of engine weight, he said that if figures were quoted to include weight of fuel for each of the three schemes, a much bigger difference in weight became evident. His own calculations for engine plus fuel weight were 2,940 lb for shaft-drive scheme as against the author's 820 lb; 3,700 lb for the ducted-gas method as against 1,300 lb; and 4,576 lb for the ducted-air scheme as against 2,340 lb. These figures were on the basis of a 200-mile stage-length or an endurance of about two hours.

MR. P. R. PAYNE (Auster Aircraft) said that since the lecturer had allowed for additional tail-rotor weight in the shaft-drive scheme it was to be assumed that the figure given referred to a single-rotor helicopter. A twin-rotor machine with shaft-drive would have considerably lighter transmission-shaft weights. He also thought that a ramjet at the blade tip, running at a Mach number of 0.8, was a better means of rotor propulsion than any other up to a duration of about 30 minutes.

MR. G. CLARKE (Alvis) asked whether, in the shaft-drive application, the designer would be faced with the problem of a constant-speed rotor and, consequently, a constant-speed turbine, or whether the speed of both would be variable. If the latter, would the variable-speed turbine be able to meet the demands in power made upon it?

DR. G. S. HISLOP (Fairey Aviation), the chairman, mentioned in summing up the discussion, that a small American helicopter (the Sikorsky S-59) had recently flown successfully with a fixed-shaft turbine to drive the main rotor shaft. In this case, the turbine was fairly large in relation to the size of the machine—which might indicate that a reasonable reserve of power was desirable with the gas turbine as a helicopter power-plant in order to avoid engine control problems.

MR. JOHN BROWN, in reply to the discussion, said that he had deliberately omitted the ramjet because the scope of his investigations at the National Gas Turbine Establishment had been limited to a Mach number of 0.6; they were hoping to extend the scope of the investigations at a later date. He had, also, deliberately avoided the question of engine plus fuel weight as this would have entailed specifying a given hover endurance and cruise endurance. He preferred to leave his calculations purely as an indication of engine performance, and operators could then make their own estimates of engine plus fuel weight according to the type of helicopter under consideration and the percentage of power it required in the various flight conditions.

He thought that the free power turbine (shaft-drive) should be able to accommodate a variable-speed rotor (between 200 and 400 rotor r.p.m.) without a drop in power output.

He agreed that an increased propulsive efficiency of the jet would result from higher blade-tip speeds. At the tip speeds he had used, the propulsive efficiency of the jet was only about 50 per cent, which accounted for a large measure of the difference between it and the shaft-drive scheme (approximately 80 per cent efficiency). With a higher blade-tip speed the ducted-gas and ducted-air schemes might show up to better advantage in a comparison of the three methods.

CHRISTCHURCH RUNWAY EXPERIMENTS

SOIL-STABILIZATION—i.e., the improvement of soil as a "structural" material, usually by the introduction of a binding agent such as cement—is being increasingly employed in runway construction.

One of the largest runway stabilization projects to be carried out in this country has recently been completed at Christchurch, Hants, Airfield, which is operated by the de Havilland Airspeed Division under lease from the Ministry of Supply. The project has involved the replacement of a permanent grass runway by a stabilized-soil runway 4,500ft in length and 100ft in width.

The subsoil was found to be of a satisfactory nature, but it was necessary to remove the turf and topsoil to a depth of 6in and to use gravel to regain the required level. Topsoil of a high organic content, such as existed at this site, cannot be economically cement-stabilized.

The work was carried out without interruption of flying activities. Soil stabilization to a depth of 6in was performed very largely by Howard single-pass soil-stabilization plant, made by Rotary Hoes, Ltd., of Horndon, Essex. Three complete "trains" of this equipment were employed, usually working in echelon. Two of the trains were hauled by crawler tractors designed and made by the same company for this specific duty. The work was completed at a rate of 270 sq yd/hr for each train, this time included final rolling.

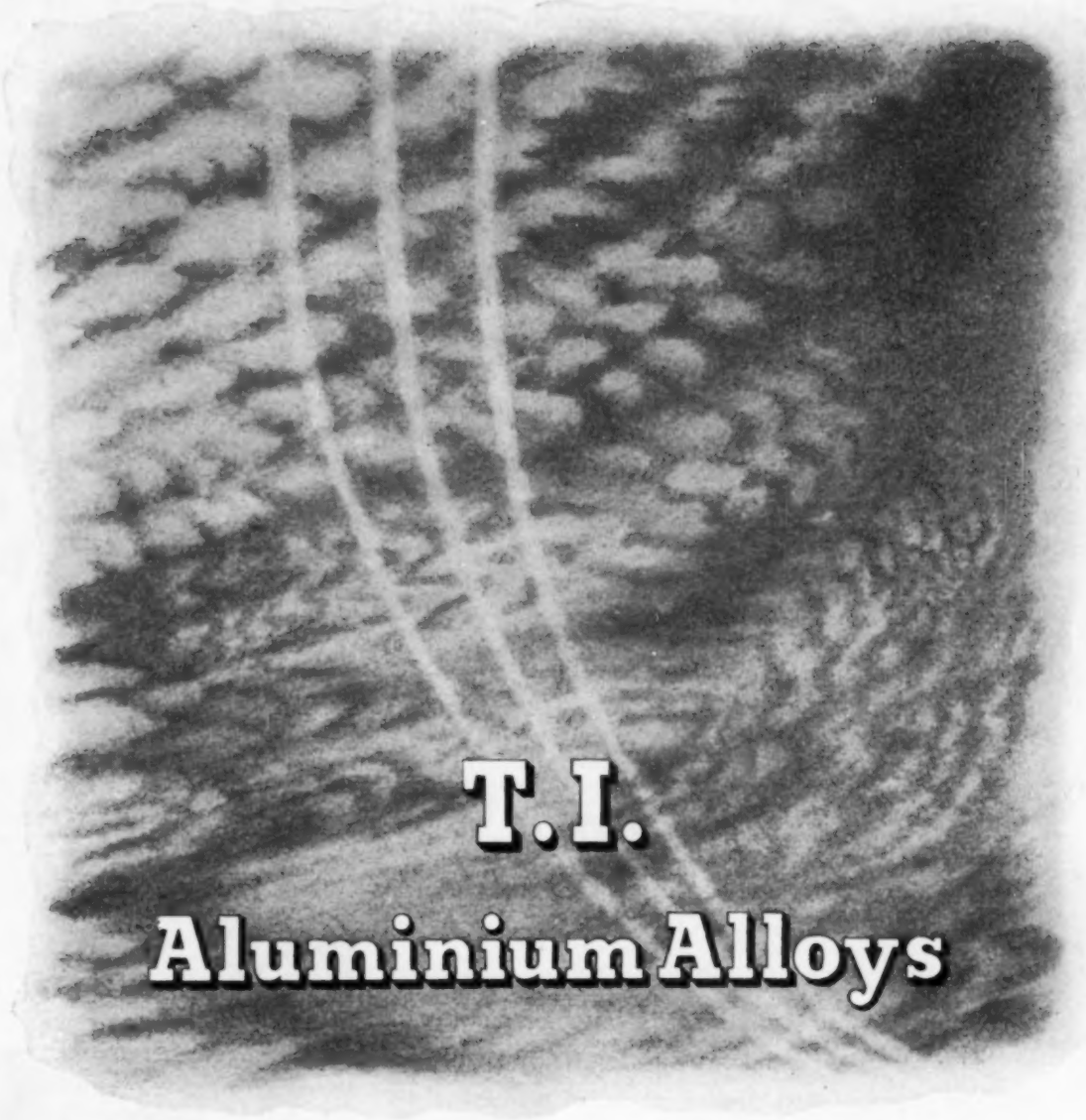
The final tar or bitumen surfacing added to the soil cement was of the minimum thickness necessary to give protection from mechanical and climatic damage.

Preliminary trials included stringent tests with Service aircraft on seven different types of surfacing. As a result, three types were selected for long-term test. Part of the runway will be surfaced with tar and chippings, part with a 2in tarmac carpet, and part with Jetcrete, a special emulsion developed to withstand the effects of use by jet aircraft.

The work forms part of a Ministry of Supply experimental programme and is being carried out by the Military Engineering Experimental Establishment, Christchurch, with the co-operation of Royal Engineer units of the Army.

AVIATION FILMS

IN the latest list of 35 mm and 16 mm documentary and instructional films available on loan from Petroleum Films Bureau (29 New Bond Street, London, W.1) are ten on aviation subjects. They include the now famous series on the Farnborough Shows and also an individual aircraft series; these last are short films dealing separately with the following: Vickers-Armstrongs Valiant, Short S.A.4, Boulton Paul P.111, de Havilland Comet, Bristol Brabazon, and Avro 707A and 707B.



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He was in Parliament Square (Cape Town) two days ago

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A good example of Smiths' ingenuity is this new Linear Desynn Transmitter. Specially designed for use in restricted space, it is 4-oz. lighter, and smaller, than the existing Desynn Position Transmitter. The indicator can be supplied with single or double pointer. Electrical supply is 24-volt D.C.

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"AERIAL WORK" IN THE U.S.S.R.

Aeroflot's Duties Additional to Airline Operation

IN a recent article we were able to give some details of Soviet Russia's airline system, based on facts disclosed by the "Aeroflot Year Book, 1954." The same source of information also sheds light on a good many other Russian aviation services, all of which are performed by Aeroflot, whose activities are not by any means confined to airline operations; it is, in fact, the "Soviet civil air fleet," with a wide range of duties.

THE Soviet Union made its first experiments in the use of aircraft against plant pests in the summer of 1922. During the two following years the problem of aircraft spraying was examined and the technical requirements for aircraft and equipment were worked out. In 1925 the first air expedition was organized to combat locusts along the River Kuma in the Northern Caucasus. The work of this expedition confirmed the effectiveness of aeroplanes for anti-locust work.

Since that time aircraft have been used on an ever-increasing scale for the protection of crops. Between 1931 and 1940 millions of acres were treated from the air, the method saving thousands of tons of chemicals and many million man-hours in comparison with the older surface-processes of pest destruction. Today this work is continuing on a vast scale.

Another aspect of aerial farm work in the U.S.S.R. is the spraying of mineral fertilizers. The first experiments in aerial fertilization of winter grain were made in 1944 over state farms in the Voskresenskiy district of Moscow province. The advantages were very soon apparent and the subsequent use of aircraft over hundreds of thousands of acres in the Ukraine, Rostov and Stavropol provinces, and in the Kuban and the Volga River area, confirmed that the aerial feeding of grain and other crops was a highly effective supplementary means of increasing the yield.

As in other densely forested countries the Soviet Union is making wide use of aircraft in connection with forestry work. Regular fire-detection patrols are flown, the aircraft carrying parachutists specially trained to fight forest fires. It is claimed that up to 80 per cent of forest fires throughout the U.S.S.R. are spotted from the air. During 1952 over 60 per cent were extinguished by parachutist fire-fighters. An example may be quoted from the *Year Book*:—

"In the summer of 1951 the pilot Repin and his observer Koveshnikov discovered a forest fire 20 km away from the village of Ivanovka. Parachutist firefighter Ivanov was dropped near the fire. With the aid of an entrenching tool and ammonite cartridges which were dropped to him from the aircraft, he made a barrier in the form of a trench; the fire went out on reaching the trench. Two days later the same aircrew discovered a fire covering an area of 5 hectares. Forty minutes later a squad of parachutist fire fighters, five men in all, was dropped near the fire with explosives and chemicals. Two parachutists began to make a barrier of the trench type with the aid of explosive, while the others began to put out the fire by spraying it with chemicals from sprayers strapped to their shoulders. The fire was soon extinguished.

Parachuting is a popular sport in the U.S.S.R. and—more usefully—parachute fire-fighters are employed to deal with forest fires. Here a parachutist is seen about to disembark from a PO-2.

A PO-2 biplane of the type used in large numbers for crop dusting and spraying and other agricultural work.

Aeroflot pilots also play their part in afforestation. Aircraft deliver seeds to nurseries and from the nurseries to the area to be planted. Air photography is used to survey the forests and air observation is used to plot the progress of timber rafting.

Healthy development of forests is of great importance in mastering the sandy wastes which occupy a vast area of the Soviet Union. Every year sand buries considerable tracts of cultivated land, and it also interferes with irrigation systems; but it is possible to return these areas to cultivation if the sand can be stabilized by planting trees which will grow in a desert climate. One type suitable for forest cultivation in deserts is the saksaul, and it is used to make tree screens around oases and along the edges of canals and rivers.

Renewal of old saksaul plantations and the planting of new ones requires a great outlay of labour, and aircraft have now been brought in to help. At present, aerial sowing of saksaul is being done over the deserts of the Turkman and Uzbekistan areas.

A special section of Aeroflot, known as the "Fish Air Force," initiated in the far north in 1927, assists the country's fishing industry. The comparatively limited view from the crow's-nests of ice-breakers used on White Sea sealing expeditions led to the use of aircraft for spotting. The first reconnaissance brought excellent results and in the following years reconnaissance aircraft were used by the trapping industry and also by the fishing organizations. Experiments were later extended to the Black Sea and the Caspian and subsequently to the Far East. No large-scale fishing or trapping expeditions are now undertaken without the assistance of aircraft.

Apart from their spotting work, aircraft are used for delivering spares to ships which have suffered breakage or accident and they are also employed for rescue work—sometimes in cases where fishermen or trappers have been carried to sea on drifting ice. Aeroplanes are also used for the transport of fertilized spawn, young fish, and fully grown fish of valuable species to supply newly constructed reservoirs and to enrich and improve the fauna of artificial seas and lakes. Food is also dropped to fish in such places.

Reindeer breeders suffer heavy losses caused when herds are attacked by wild animals, the most numerous of which are wolves. In the Nenets National Region alone, wolves kill an estimated 5,000 to 6,000 reindeer every year. The vast size and small population of the northern tundra make it difficult to combat these ravages, but since 1951 the destruction of wolves on a large scale has been undertaken with the aid of aircraft. Huntsmen in low flying PO-2 biplanes seek out and shoot the animals. Whole packs have been destroyed by such attacks from the air. Wolf hunting from aircraft is also done in other parts of the Soviet

Russian flying doctor: A surgeon and nurse from an Aeroflot ambulance PO-2 in the Borinsk mountain region. The PO-2 appears to have landed on the shore of a river with not too much space in hand.

"AERIAL WORK" IN THE U.S.S.R. . . .

Union, in particular in the Trans Volga and South Ural steppes.

Yet another division of Aeroflot is engaged on geological survey, largely in remote and sparsely inhabited parts of the country. Oil has been found in Fergana and new coalfields in the east of the Union have been discovered with the help of aircraft. Allied with this work, of course, is aerial photography, which is widely used to accelerate and simplify the completion of maps, the planning of new industrial enterprises and the construction of roads and railways. Air mapping has been extensively used in planning the development of the irrigation of drought zones.

Aeroflot is also responsible for the air ambulance service in the U.S.S.R. and, according to the *Year Book*, aircraft of the ambulance service, in the Ukrainian S.S.R. alone, flew 102,754 medical staff, 21,106 patients and 425,755 kg of medicine and medical supplies in the period 1944-51.

Most of the other figures quoted are of little value; they are the usual type of statistics issued by the U.S.S.R., with a string of percentages and no original figures. A typical statement is:—

"The following figures will indicate the growth of the Soviet air ambulance service. By 1946 the number of air ambulances had multiplied five times in comparison with 1940. The number of air ambulance stations had more than doubled by 1951 in comparison with pre-war figures, and the number of flights had almost trebled. More than four times the number of doctors were carried by air ambulances and more than six times the number of sick people, whilst the quantity of medical supplies carried was almost five times greater."

The Soviet air ambulance service was begun as early as 1927, with K-3 aircraft carrying two stretcher cases. Subsequently various machines were used for this work and by 1933 there were 50 ambulance aircraft in service. The air ambulance was much used during the war and the PO-2 was and probably still is the most used Soviet ambulance aircraft although Li 2s and AN 2s are now in service. The AN 2 is claimed to be particularly suitable for this work as a result of its good landing and take-off qualities, which permit operation from very small areas. The large aircraft are equipped with X-ray apparatus.

During the early period of its development the ambulance service was used almost exclusively for transporting serious cases from remote regions where there was no qualified medical help. Now the character of the service has changed considerably. Apart from transporting serious cases to the town hospitals, and doctors to the sick, aircraft help local hospitals and young doctors in outlying districts by bringing in qualified consultants to help them.

Apart from the numerous air ambulance stations distributed over the whole vast territory of the U.S.S.R., there is a central station, situated in Moscow, which serves the whole Soviet Union. It has Li 2 aircraft at its disposal. Among its functions is the rapid delivery of urgent medical supplies to various parts of the Union and the transport of medical "brigades" to carry out examinations and to hold consultations of all kinds.

Dr. G. P. DOUGLAS

WE regret to hear, from former colleagues of his at R.A.E. Farnborough, that Dr. G. P. Douglas, M.C., O.B.E., D.Sc., F.R.Ae.S., died on October 16th, at his home in Camberley after a short illness. After distinguished World War I service, during which he received serious wounds, Dr. Douglas joined the R.A.E. in 1916. In 1919 he was appointed engineer in charge of wind tunnels, and in 1934 he became deputy chief scientific officer and head of the aerodynamics department, a post which he held until his retirement last year. He served on the council of the R.Ae.S. and on various committees of the Aeronautical Research Council.

Dr. G. P. Douglas.

During this time, says a colleague of his, Dr. Douglas built up the aerodynamics department both in its equipment and staff to match the development of aircraft from their early simplicity to present complexity; and he helped to strengthen the good relationship existing between the industry and his staff. Dr. Douglas leaves a wife and a daughter.

DECCA DISSECTED

THE past history and future possibilities of the Decca Navigator system were the subject of the inaugural lecture of the Radar Association's 1954-55 season, held in London on October 13th. The speakers were G/C. E. Fennessy, O.B.E., B.Sc., M.I.E.E., F.Inst.Nav., and Mr. H. G. Hawker, A.R.C.S., B.Sc., and the meeting was under the chairmanship of A. V-M. D. C. T. Bennett, C.B., C.B.E., D.S.O., F.R.Ae.S.

G/C. Fennessy sketched the origin and early development of the system, pointing out that—like Gee—Decca owed its inspiration to a single individual, in this case Mr. W. J. O'Brien. The collaboration between Mr. O'Brien and Mr. H. F. Schwarz, chief engineer of the Decca Company, led to the adoption of the system, under Admiralty sponsorship, for the task of sweeping and following narrow channels through the enemy minefields during the Normandy invasion. After sea trials organized by the Ministry of Transport, Decca was widely adopted by merchant shipping and the coverage was increased from a single chain of stations in 1946 to the present six chains operating in Europe.

The concurrent development of the system as an air-navigation aid, the speaker remarked, showed great technical possibilities but soon became hedged about with "politics": this was in contrast to the more realistic attitude of the mariner, who was concerned mainly with the positive advantages which the system offered him in its existing form.

Mr. Hawker described the working principles of Decca, showing with block diagrams how the four basic radio frequencies transmitted by a chain serve to generate the permanent "fine" hyperbolic patterns in space, two of which give the accurate fix, and also to superimpose the coarse "lane identification" patterns which give a once-per-minute check on the lane reading of each Decometer.

Mr. Hawker concluded by outlining the proposed DECTRA and DELRAC systems for trunk-route navigation and longe-range coverage respectively, after which a film was shown on the use of the Decca Navigator in helicopters.

B.O.A.C.'s NEW 'PHONE EXCHANGE

BELIEVED to be the largest of its kind in the world, the private automatic branch exchange in the new B.O.A.C. building at London Airport is large enough to provide a telephone service for a small town. Installed by the Automatic Telephone and Electric Co., Ltd., it has 1,300 extensions able to communicate with one another without the intervention of an operator; 95 exchange lines; and 60 private wires. Among its new features is a "hold for enquiry" facility, which enables users to hold an incoming exchange call and to make, at the same time on the same telephone, a further call to either an external or internal line.

Although the installation has been in operation for only a few weeks, it has, according to B.O.A.C., "proved of immense value."

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★ The Sapphire is manufactured under licence by the Wright Aeronautical Division of the Curtiss-Wright Corporation in the U.S.A., where it is known as the Wright J.65.

This painting by Roy Nockolds, one of a series of abstract designs specially commissioned by Armstrong Siddeley, gives something of the feeling of the immense thrust developed by the Sapphire turbojet propelling a fighting aircraft to its operational height in a matter of minutes . . . an essential requirement for the modern military aeroplane.

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★ *The Grumman*
F9F-9 TIGER *fighter*

★ *The*
MARTIN B57 *(Canberra bomber)*

The Gloster
JAVELIN *all-weather fighter*

The English Electric
P.1. *fighter*

★ *The North American*
FURY *fighter*

★ *The Douglas A4D*
SKYHAWK *bomber*

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AIRCRAFT INTELLIGENCE

The 1,000th Boeing B-47 Stratojet to be built by the Boeing Airplane Company's Wichita Division was rolled out on October 14th in the presence of 30,000 employees. The "posters" on the aircraft are mainly, and literally, composed of money—more than $10,000 in bills and coins, spontaneously contributed by Boeing employees to the National Foundation for Infantile Paralysis.

Belgium

Avons for Hunters. It is reported that the Fabrique Nationale plant is preparing to build Rolls-Royce Avon RA.21 and RA.23 turbojets to power the Hawker Hunter intercepters scheduled for production in Belgium and Holland.

France

Hurel-Dubois H.D.31 and 32. The H.D.31 prototype has now completed all its official tests and has been accepted by the Services Techniques. During December it will be flown to Africa for tropical trials. The H.D.32 will be flying in November with a number of modifications, including a new single-fin tail.

Nord N.C.856—Special Tests. Technicians from the S.N.C.A.N. and Schneider organizations have demonstrated the operation of an N.C.856 air observation post with special equipment. A Schneider Fieux catapult enabled the machine to get airborne in 65ft, and to land with arrester equipment in 40ft.

Brêguet Deux Ponts. During dropping tests conducted by the Bréguet concern in conjunction with the Direction des Etudes et Fabrications d'Armement, a load of 14¼ metric tons was parachuted in a single operation lasting 18 sec. This is thought to constitute a world record. The loads were carried on several platforms weighing from 1-3 metric tons each and each about the size of vehicles or artillery pieces used by the French Armed Forces and NATO. The last load—of 3 metric tons—was dropped from the lower deck and automatically released nine parachutes stowed on the upper deck.

U.S.A.

Martin XP6M-1 Seamaster. Intended for fast (high subsonic) minelaying operations, the Seamaster flying boat is expected to fly next spring. Originally it was to be powered by four Wright J67 two-spool turbojets, but in their place Allison J71s, each of 9,500 lb static thrust, are being installed. The aggregate of 38,000 lb thrust (dry) will be much increased by afterburning.

Boeing RB-52 Developments. Interchangeable pressurized "pods" fitted in the bomb bay of the Boeing RB-52 will contain respectively, aerial cameras and two operators, and electronic countermeasure devices with a crew of six. (Only the crew compartment and tail gunner's position are pressurized on B-52 bombers.)

Bell V.T.O. It is understood that a vertical take-off aircraft of Bell manufacture has been flying "under limited operating conditions" for about six months. A private venture, it is powered by two Fairchild J44 turbojets, loaned by the U.S.A.F. These are mounted on the fuselage just beneath the wing and are tilted for directional control. The aircraft was referred to on this page in our issue of October 8th.

PICTORIAL THREE-VIEW DRAWINGS

A FEATURE which has won wide acclaim is the "pictorial" three-view drawing appearing weekly on this page. These drawings are of value to the technician, observer/spotter and model-maker alike, and constitute a unique record of aircraft design and styling. Such has been the demand that they are now offered in glossy-photograph form, wherein the merit of their execution can be fully appreciated. The following are now available (postcard size, 5¼ in x 3¼ in, 8d each, post free; 12 or more, 7½d each; cash with order; also in usual *Flight* photographic print sizes, at prices on application):—

Armstrong Whitworth Meteor N.F.14, Avro 707C, Avro Canada CF-100, Avro Shackleton Mk 2, Avro Vulcan, Bristol Britannia 100, de Havilland Vampire Trainer, de Havilland Venom N.F.3, English Electric Canberra P.R.7, Fairey Gannet A.S.1, Gloster Javelin FAW.1, Hawker Hunter F.1, Hawker Sea Hawk F.1, Hunting Percival Provost T.1, Short S.B.6 Seamew, Vickers Valiant B.1, Vickers Viscount 701, Vickers-Supermarine Attacker F.B.2, Vickers-Supermarine Swift F.4.

Day or Night: Fair

or Foul

GERMANIC in concept, the "night-and-all-weather" fighter (as the class was originally styled) has been developed to its highest pitch in Great Britain. For R.A.F. and F.A.A. service, respectively, we have the Gloster Javelin FAW.1 (Armstrong Siddeley Sapphires) and the D.H.110 (Rolls-Royce Avons), both capable of supersonic speed in the dive and of carrying the deadliest air-to-air missiles. In its present form the Javelin not only flies but *fights* at levels above 50,000ft, and a long and fruitful period of development lies ahead of both types. Traversed by a contrail, the largest picture —by Russell Adams—shows a Javelin at 35,000ft; the small view shows the ports for the four 30 mm Aden guns. Above, the D.H.110 is seen undergoing trials aboard H.M.S. *Albion*, and below, the same machine displays its ample wing area, flaps, air brakes, all-flying tail, and fixed "droop-snoot" leading edge sections.

CESSNA T-37: LEADING DATA

Two Continental J69-T-15 turbojets of 920 lb thrust each. Span, 33ft; length, 27ft 1in; height, 8ft 9¼in; wing area, including flaps and ailerons, 181.8 sq. ft; horizontal tail area, 50.8 sq ft, 32.48 sq ft of this being tailplane. Empty weight, 3,116 lb; design gross weight, 5,400 lb.

Maximum speed at 35,000ft with tanks half full, 393 m.p.h.; maximum range with 30-min fuel reserve, 935 miles; speed for maximum range, 310 m.p.h.; stalling speed, 92 m.p.h. (clean) or 77 m.p.h. (full flap); rate of climb at sea level with military power (820 lb thrust each engine), 3,000 ft/min; normal-power service ceiling with tanks half filled, 39,800ft; one-engine ceiling (mil. power) 19,200ft.

U.S.A.F. TRAINER

IN 1952 the United States Air Force formulated a specification for a new jet basic trainer. A competition was held for a suitable design and, in December of that year, the Cessna company were successful against eight other manufacturers who submitted 15 different designs.

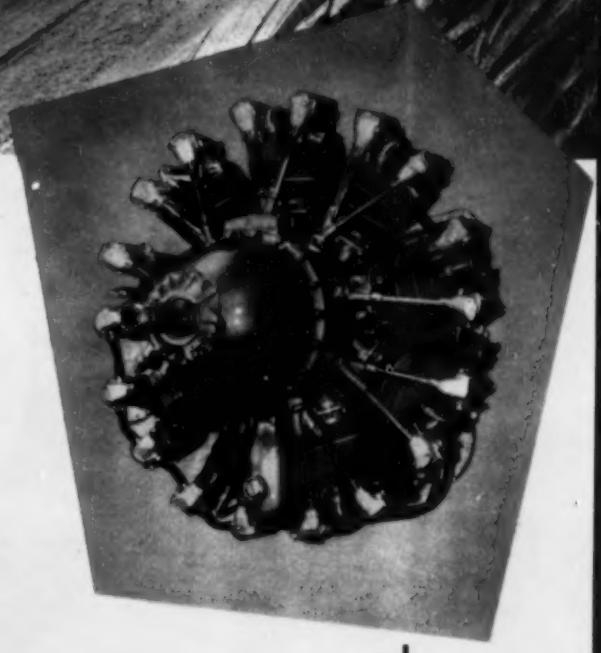
The Cessna design, the Model 318, was bold and workmanlike; and, very unusually for an American trainer, it had side-by-side seating. The power units specified were two Turboméca Marborés, of the pattern for which Continental Motors were then negotiating a licence-agreement with the French company. Cessna were awarded a letter-contract for about $1m, covering the cost of production engineering and tooling sufficient for a high rate of output at the company's new Prospect plant, about five miles south-west of Wichita, Kansas.

Designated XT-37, the prototype (the first aircraft, incidentally, to bear a 1954 serial on its fin) is now well advanced in its flight trials, and it has been described by Bob Hagan, the Cessna chief test pilot, as "a honey of an airplane." It is designed to teach intermediate pupils the techniques and manœuvres required by combat pilots. Equipment includes provision for day and night instrument flying; oxygen; heating and ventilation; jettisonable canopy; and ejector seats. Construction is all-metal. A hydraulic system operates the retractable nosewheel undercarriage, flaps and a speed-brake hinged behind the nosewheel.

The power unit is the Continental J69-T-15 Marboré, illustrated above, which is an American development of the basic French engine, giving higher output. Each intake is fitted with a hinged debris guard which retracts with the undercarriage. Both the primary flight-controls and engine controls are duplicated.

As the T-37A, the new trainer will be built in large numbers. Cessna already hold a second $4m contract covering the manufacture of the first eleven machines.

Versatility



The ALVIS LEONIDES Engine as installed in the Hunting Percival Pembrokes of the Belgian Air Force has proved itself to be an exceptionally versatile and economic power unit for aircraft of the medium power range. 550 b.h.p., 9-cylinder air-cooled radial engine. Weight complete 796 lb. Power/weight ratio 1·45 lb. per b.h.p. Overall diameter 41·5 inches.

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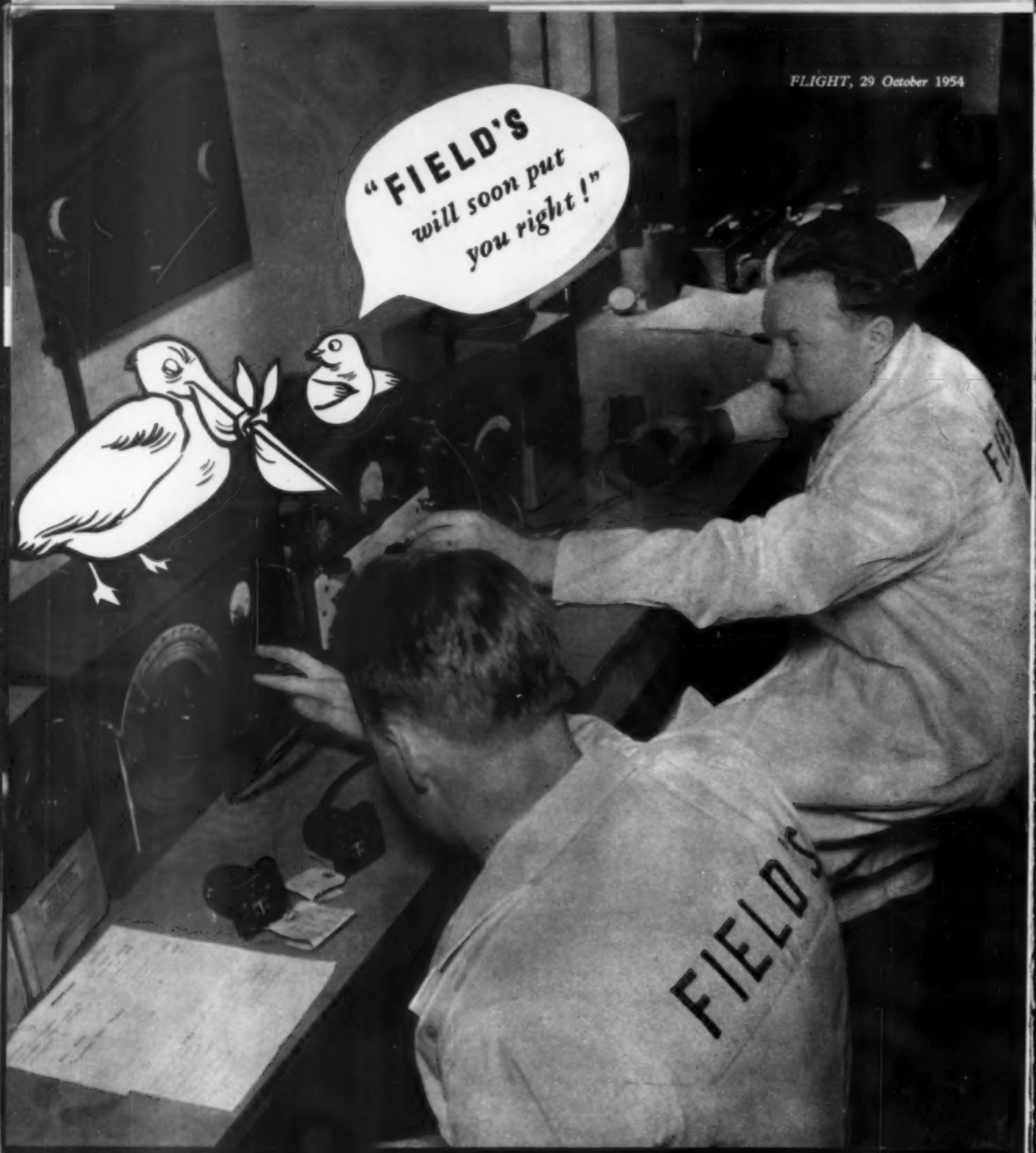

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BRITAIN'S AIR WAR: TELEVISION HISTORY

"WAR IN THE AIR," the long-looked-forward-to series of B.B.C. television films illustrating Britain's development as an air power and, in particular, the air events of the last war, is to begin on November 8th. The series will comprise 15 films, each half-an-hour in length, which will be televised weekly on Monday nights.

Behind the actual programmes lies an immense amount of background work, performed by the B.B.C. with the close co-operation of the Air Ministry. The original idea of presenting a television series of World War II films was raised in 1947, but was dropped. Work on the "War in the Air" series began in February of last year, when a viewing committee was formed under Air Chief Marshal Sir Philip Joubert, and the support of not only the Air Ministry but also the Admiralty, War Office, Ministry of Supply, and the Central Office of Information had been obtained.

It was decided that the producer should be Mr. John Elliott, who is also responsible for the script. Some 3½ million feet of film from the R.A.F. Film Library were viewed and the subjects catalogued; then the search was widened to include other British sources. Much assistance was received from the Air Historical Branch of the Air Ministry.

By the summer of 1953 a total of some five million feet of film had been viewed, checked and catalogued. Selection and editing continued, together with script work by the production department. Outline scripts were submitted to the Air Ministry for checks on accuracy. At about the same time the search for suitable films was widened still farther to include foreign items: Elliott sent to France to investigate French and N.A.T.O. sources, and other members of the B.B.C. team visited the U.S.A., Canada and other Commonwealth countries.

In the autumn of 1953, actual production and editing began. This continued until, at the beginning of this year, early "rough-cuts" were ready, and the assembly scripts had been completed. Some linking scenes and background pictures remained to be shot, and this was done at various R.A.F. stations and 11 Group fighter-control room. The extent to which original material has been used is indicated by the composition of the total film: 90 per cent is combat material, five per cent specially shot for war-time documentaries, and five per cent specially shot by the B.B.C. Every effort has been made to provide and check authenticity of detail in the "dated" scenes.

Discussions on the programme music began in the early summer of this year. The composition was shared among some of this country's leading composers, including Sir Arnold Bliss (who composed the title music), Malcolm Arnold (who wrote the music for "Sound Barrier"), and William Alwyn. All shooting was completed a few months ago, the first nine "rough-cuts" had been made, and the recording of the commentary began. Thus the final stages of what has been almost a two-year job were reached.

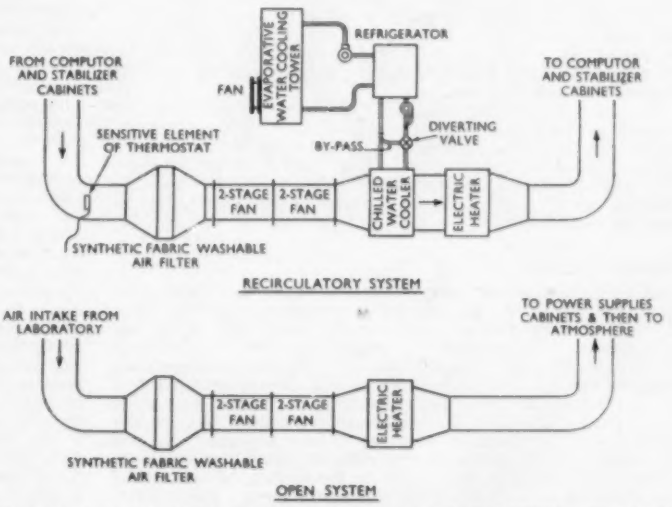
In the first film, to be shown on November 8th, the inter-war years are recalled and events leading up to the eve of the Battle of Britain are traced. The second film shows the Battle of Britain, and the beginning of night attacks on London, and the third goes on to portray the Battle for Europe, recalling the first thousand-bomber raid. Subjects to be covered in later films of the series include the Battle for the Western Oceans from 1940-42; international operations in the Middle East; the second phase in the Battle for Europe; the great dam raids; D-Day and the liberation of France; the Battle for the Eastern Oceans over the 1942-45 period; "Facing New Weapons"—the V-1s and V-2s and the defence of London; victory in Europe and in the Far East. The last three films in the series deal with British air power from the capitulation of Germany until the present day.

Incidentally, the Radar Association has announced that the next lecture in its 1954-55 session is to be given, on November 10th, at the B.B.C.'s Lime Grove Studios, when the speakers will be G/C. Philip Dorte and Mr. Elliott. Their subject is the production of the "War in the Air" film series.

Cooling an Electronic Brain

IN our issue of October 15th we published an account of the great Tridac electronic computor of the R.A.E. and added a note to the effect that a smaller and simpler machine, named AGWAC (Australian Guided-Weapons Analogue Computor), had been prepared for use at the Long-Range Weapons Establishment at Salisbury, South Australia.

This latter computor has now been installed at Salisbury, and will be of great assistance in solving missile problems. Although it consumes only 25 kW of power (Tridac can consume 650 kW) AGWAC nevertheless has to dissipate a considerable amount of waste heat. This is rendered particularly important owing to the fact that the accuracy of the equipment depends on certain circuit constants which vary with temperature, and the limits have therefore been fixed at 76± 3 deg F. An air-treatment engineering firm, Eaton-Williams (Millbank), Ltd., have devised an automatic conditioning system for the temperature-critical parts of the "brain" which consists of two main sections (see diagram).



The two main portions of the air-conditioning system used in the AGWAG, with electric heating and water/evaporative cooling.

The recirculatory system, in which temperature is accurately controlled, supplies the computors themselves. For heating, an electric heater is provided with nine loadings up to a maximum of 13 kW; for cooling, a finned cooler battery is fitted, with a peak extraction rate of 40,000 B.Th.U./hr. The cooler is fed with water chilled to 45 deg F (the term "Brainwashing" seems appropriate) which is condensed in a separate circuit including an evaporative tower. The water flow is governed by thermostats in the return duct from the computor equipment. The system incorporates means for maintaining the relative humidity of the cooling air below 90 per cent and to give warning of any failure.

The open system does not require dehumidifying equipment, but a small heater is provided to prevent condensation. The equipment employed includes Millbank washable filters of synthetic fabric, 19in two-stage contra-rotating fans by Woods of Colchester and Teddington Za series thermostats. Complete spare fans are fitted, these merely idling under normal conditions but being capable of being brought in simultaneously with a spare thermostat at the turn of a control switch. The whole installation is relay-controlled throughout, controlled by a single on/off switch.

CAR PERFORMANCE COMPARED

NOW on sale is the latest collection of road test reports on new cars, reprinted from *The Autocar* under the title *"The Autocar" Road Tests 1954*. The largest yet published, this edition contains reports on 31 vehicles, occupying 116 pages and including numerous illustrations; twenty-one British cars are described, three German, three French, two Italian and two American. It is obtainable from bookstalls at 6s, or from the publishers (postage 7d) Iliffe and Sons, Ltd., Stamford Street, London, S.E.1.

The Comet Accidents: History of Events

Sir Lionel Heald's Introductory Summary at the Inquiry

HERE we give, in slightly condensed form, a report of the summary with which Sir Lionel Heald, Q.C., for the Crown, opened the Comet Inquiry in London on October 19th. Subsequent proceedings are reported on earlier pages of this issue.

AT the opening of the inquiry Sir Lionel Heald said that he felt justified in putting before the court a positive explanation of what was believed to have happened to the Elba Comet. This he proposed to do by means of a closely reasoned and documentary argument, which started from the known facts and proceeded by a process of elimination and deduction to a conclusion which could actually be shown to be sound by visual inspection of certain parts of the wreckage, and which Sir Arnold Hall would explain.

He added that if anyone had a better explanation than Sir Arnold Hall's the court would be very glad to give it the fullest consideration with perfectly open minds: at the moment he knew of no other explanation which fitted the facts.

Before summarizing the facts, Sir Lionel said that time after time in the history of the application of science to the service of man there came a moment when some radical new departure—the use of a new principle, material or method—led to a disaster which cost many lives and at first sight appeared to close the road to further progress because the forces of Nature seemed too strong to be controlled. But history also showed that, when such a disaster happened, men had never been afraid to re-examine the whole project in the light of later knowledge and research, and often they had risked their lives in the process.

Such accidents might be regarded as the price of progress, and their results were not merely negative. Already the Comet had undergone elaborate and searching tests which would have been far beyond the means of any single organization. No aircraft in history had ever been subjected to such an examination: it was reasonable to hope that the results would be of the greatest value, not only to the aviation industry, not only to this country, but to the whole world, by enabling high-speed air travel to be developed with increased safety and efficiency, and so bringing the nations closer together.

Referring first to Comet G-ALYP, Sir Lionel pointed out that this was the first Comet ever to go into service—its first scheduled passenger service was on May 2nd, 1952—and at the time of the accident it had flown 3,681 hours. It was one of the earliest to be built at Hatfield, and was properly described as D.H.106 Series 1, construction No. 06003. It was powered by four D.H. Ghost 50 engines, each developing 5,000 lb static thrust.

Pressurization

For the physical well-being and comfort of the passengers, they were accommodated in a pressurized compartment so that, when flying at 40,000ft, a cabin pressure equivalent to only 8,000ft was maintained. The pressure was regulated so as not to exceed 8.25 lb/sq in differential pressure. Obviously this differential pressure required that the wall of the cabin should be very strong, and it was only the remarkable development in the field of aluminium alloys during the last 20 or 30 years that had enabled the necessary lightness to be combined with the desired strength. No one suggested that there was anything wrong or defective or dangerous about the aluminium alloys used in the Comet, or that it was impracticable to build a pressure cabin from them. The problem was one of design and of relative weight and strength, having regard to the life which the aircraft was to have. Neither was there anything inherently impracticable in the carriage of passengers in pressurized aircraft at high altitudes.

The Elba Comet's 3,681 hours represented over a million miles' successful flying. The total flying hours on Comets with B.O.A.C. up to the date of the first accident were approximately 24,100; thus this was by no means a mere experiment. The trouble was that today, for a commercial aircraft of this type, a very much longer life had to be relied on than was previously contemplated.

The accident to G-ALYP, Sir Lionel continued, happened during a regular flight from Singapore to London on January 10th this year. The aircraft arrived at Rome airport, Ciampino, from Beirut at 0830 hours and left at 0931 hours G.M.T. Nothing of any significance happened during this stop.

"On leaving Rome the aircraft climbed rapidly in accordance with the flight plan, and at 0950 hours, when the last message was received at Ciampino, the pilot reported that he was at 26,500ft over the Orbetello beacon, and intended to continue to climb to 36,000ft as planned. . . ."

That was the last that the base heard of G-ALYP, Sir Lionel continued, but the pilot of Argonaut G-ALHJ, which had taken off from Rome earlier but had been overtaken by the faster machine, had several wireless conversations with the Comet. Soon after 0950, he received a message from the Comet which read "GHJ from GYP: did you get my—" when the transmission stopped. It seemed likely that that was the moment at which something happened to the Comet.

The absence of any further message to the ground stations provided a negative indication, after which the usual emergency services were soon alerted. Meanwhile, positive indication of an accident was received by a number of the inhabitants of the Isle of Elba. After quoting from the statements of two eye-witnesses, who had seen pieces of the aircraft falling, in flames, into the sea, Sir Lionel gave an account of how the chief officer of the Harbour Authority at Portoferraio, Col. Lombardi, had immediately arranged for a search by aircraft and ships, and how the search for wreckage was taken up by the Italian and British Navies.

Concerning the recovery of the wreckage, Sir Lionel said "It seems so easy now, when we see the results, but it has to be remembered that the wreckage consisted of literally thousands of pieces of material scattered over a wide area at the bottom of the sea; yet between February and September of this year 80 per cent of the aircraft structure was recovered and is here in England now. Eighty per cent of the power units were recovered and 50 per cent of the equipment, and the total was 70 per cent of the recoverable weight of the aircraft." The most important element in the operations, he said, was that all four engines were recovered; three were practically undamaged but the fourth was damaged by contact with the water. The speaker was able to advise the court, however, that "you can safely give those engines a completely clean bill of health and be quite clear that there was no question of failure or defect in them and that they had no part whatever in the accident."

Sir Lionel observed that it had only been possible to obtain the full value of the investigation of marks, scratches and indentations on the wreckage because of the care taken in the salvage operation. "It is impossible to exaggerate the value of this," he said, and continued: "The Accident Branch of the Ministry of Transport and Civil Aviation had, of course, gone into action at once as soon as the accident was reported, and they were making investigations in all directions. They arranged for the wreckage as it came up to be sent to England, and the Royal Aircraft Establishment agreed to carry out an examination of it; but, of course, this took time and meanwhile other events occurred here in England which I must now mention. I shall call evidence to show what happened in London immediately after the accident became known, as it is clearly important that you should be satisfied that the action taken was reasonable then, and, perhaps, I may also say that what was not done was also reasonable."

The Comet accident at Calcutta on May 2nd, 1953, Sir Lionel next pointed out, was of quite a different character to those under inquiry, and so did not constitute another possible reason for keeping the Comets out of service. They went into service again on March 23rd; further evidence on this would be given later by the chairman of the Air Safety Board.

The second accident, to Comet G-ALYY, took place on April 8th, when the machine had done 2,704 hours. It was on a flight from London to Johannesburg, and was delayed for 24 hours at Rome, although there appeared no ground for connecting anything that happened with the cause of that delay.

The circumstances of the Naples accident, Sir Lionel went on, were in many respects very similar to those of the other. The aircraft arrived in Rome on April 7th at 1755 hours and took off on April 8th at 1832 hours: "Again the take-off was perfectly normal. The last message was received at 1905 hours, that is to say, 33 minutes after the aircraft took off, instead of 19. The pilot said that he was climbing to 35,000ft, which was the cruising height called for by the flight plan, and he was asked to report when he reached that height, but no more was heard." There were no eye-witnesses, but emergency services were put into operation that night, and the following morning some wreckage and five bodies (out of 14 passengers and seven crew) were found.

"The only clear deduction possible as regards the Naples accident is that something disastrous happened to that aircraft about 1910 hours when it was reaching a height of 35,000ft, or thereabouts, that is to say, at the time when it was reaching the top of its climb."

There was no ground in either case, Sir Lionel emphasized, for the slightest reflection on captains or crews. On the contrary,

circumstantial evidence showed that some sudden disaster came upon them while they were doing their duty: one could only pay a respectful tribute to their courage and devotion to duty. Concerning the meteorological conditions, there was no reason to suppose that violent weather disturbances existed.

Owing to the similarity between the two accidents, B.O.A.C. suspended Comet services, the aircraft's Certificate of Airworthiness was withdrawn, and the Minister of Supply directed the R.A.E. to undertake an immediate, comprehensive, technical investigation of the Comets. The Director, Sir Arnold Hall, took personal charge of the work: his report and conclusions, Sir Lionel believed, would be generally regarded as one of the most remarkable pieces of scientific detective-work ever done.

On the question of possible sabotage, Sir Lionel said "All inquiries give no support at all even for the suspicion that there was sabotage at Rome on either of those two occasions."

Four separate lines of enquiry were initially followed by the staff of R.A.E. in their investigation. Firstly, there was a study of the wreckage. As the amount of this was uncertain at that time, however, their primary line of inquiry depended on general theoretical considerations. An incidental point mentioned here by Sir Lionel was that certain matters mentioned in the Farnborough report might involve defects in the design of the aircraft, but were in no sense to be regarded as causes of the accident; consideration of these would come later.

The third line of research at R.A.E. was that of comparative tests of other Comets, both on the ground and in the air, and the fourth was that of experiments with models, test pieces and special apparatus. Assistance was derived also from certain medical evidence and experiments, and from meteorological studies.

Disruptive Force

Sir Arnold Hall had started by forming the view that the Elba Comet must have broken up at a great height, somewhere about 30,000ft, and come down in a series of certain quite clearly defined paths. As the wreckage continued to accumulate, a remarkably informative picture of the accident was built up. After giving examples of the type of indications and processes used, including the medical evidence after the examination of the bodies, Sir Lionel said "It was quite clear that there had been an almost instantaneous and tremendously powerful forward force generated inside the pressure cabin which had thrown most of the passengers and their seats forwards and upwards against the roof. But it must also have driven some of them right clear out of the aircraft without touching anything at all, because in the case of some of the bodies it was clear that they had an initial impact and in other cases that they had not."

Experiments with a one-tenth scale model of the pressure cabin had led to the belief that "within one-third of a second of the accident taking place the cabin was apparently empty." There was evidence of decompression of the lungs in the bodies of the victims consistent with sudden loss of pressure in the cabin. "It is clear on general principles that if a fracture of any substantial size (not a mere perforation, or something like a bullet hole) occurs in the wall of a tube or vessel which is under 8 lb pressure, a large hole will immediately open up and the tube will at once become what the layman might describe as a compressed-air gun. A terrific blast of air will force anything and everything out of the hole and will tend to throw the aircraft into violent contortions and so tear the whole of the fuselage to pieces."

Using a specially constructed Comet model, Sir Lionel next indicated the sequence in which, according to the R.A.E. report, the Elba Comet had broken up. "The first thing that happened was a violent disruption of the centre part of the pressure cabin" (Sir Lionel had removed a small piece in the neighbourhood of the A.D.F. aerial windows, followed by a larger piece of the pressure-cabin roof). "The next thing that happened was that the fuselage aft of the rear spar, the nose and the outer port wing fell away under what are called downward forces. Thirdly, the main part of the wing separated and caught fire. Next, Sir Arnold says, the fuselage aft of the rear spar, with the tail unit still attached, fell into the sea with the open end first and the tail-plane last. Last of all, the main part of the wing, still on fire, hit the water in an inverted position. . . .

"The fact is that this is all accounted for, and can only be accounted for, by a sudden disruption of the pressure cabin, and that is something which is *a priori* most likely of all when the aircraft is reaching its maximum height and when the greatest strain and stresses are being imposed on the pressure cabin."

The apparent cause of the disruption was obtained by a process of elimination, Sir Lionel continued. The possibility of an internal explosion, abnormally high tail-loads, insufficient tail-strength, an abnormal increase in atmospheric pressure, failure of the powered control system or the pressurization control, and inefficiency of the pilot had in turn been eliminated. Sir Arnold Hall would tell the court that there was only one thing left: "There is what is called fatigue—metal fatigue. Everything in Sir Arnold Hall's investigation supports the theory that this was the cause of the failure of the cabin, and nothing contradicts it."

"The word 'fatigue' is not an accurate technical term. It tells you nothing about the cause, and therefore scientists do not like it. But to the layman it does seem quite apt to describe in ordinary language the effect which actually occurs. What fatigue failure means is that a structure which had an ample reserve of strength when it was new might fail under its normal working load after a certain length of time. . . ."

"Whenever you have to deal with loads which are not purely static and not continuously maintained, you have to look out for the demon fatigue, and even if you start with an absolutely sound and standardized material whose behaviour is known from careful tests, supported by various applications, whether it is steel or any other material, you may be able to show it by accurate calculations to be amply strong enough to stand up to any force which it will have imposed on it during its working life; but it is unfortunately the fact that if the load is one which is repeatedly applied or alternating, the structure may fail and eventually one can say it will fail."

After mentioning that "there is no sure means of detecting by inspection of the structure or testing of the material the extent to which it is fatigued in fact," and illustrating this by an example taken from Nevil Shute's *No Highway*, Sir Lionel went on to explain the use of the S/N curve—stress plotted against number of applications. Stress-concentration points, or stress-raisers, were the weakest link in the chain—the Achilles heel of the structure.

Concerning the stress factors of safety employed in the design

This diagram shows, shaded, the portions of Comet YP which were recovered from the sea-bed of the Mediterranean between January and the autumn of this year, and which were examined minutely and re-assembled at the Royal Aircraft Establishment on a wooden frame in their original positions. For clarity, the diagram shows only the portions of skin visible from this angle; a great deal of interior equipment was also found, including all four power units. A total of 70 per cent of the empty weight of the aircraft was recovered.

THE COMET ACCIDENTS . . .

stages, Sir Lionel said: "It does seem that the Air Registration Board, who after all are the governing experts on the subject, seem to have been satisfied on the information that they had that the maximum stress-concentration due to the pressure loading under operational conditions would only be about 40 per cent to 50 per cent of the ultimate stress of the material; that is to say, that you would never get it up, under those conditions, to anything more than 40 per cent or 50 per cent, and therefore that there was still a big enough factor of safety. One sees if the ultimate stress at any given point—the maximum concentration of stress—is not more than 50 per cent, you have still a safety factor of 2 : 1."

It appeared from the R.A.E. investigations, however, that practical tests on another Comet had shown that "you could have and did have in the Comet pressure-cabin points where there was as much as 70 per cent of the ultimate stress (of the material) . . . whereas as I have said everyone had been proceeding on the basis that 40-50 per cent was about the most you would get. That 70 per cent occurs adjacent to the corners of the windows. . . ."

"No one suggests for one moment that anyone could have known this in 1946 or 1951 in Messrs. de Havillands or the Air Registration Board. . . . I think you will find that Messrs. de Havilland will agree that, looking backwards from present knowledge, the stress concentration aspect of this matter was underrated. . . ."

Although de Havillands had tested in sections what they believed to be a comparable specimen of pressure cabin, which broke down only after 54,000 hours, it appeared, said Sir Lionel, that the results of the tests might have been misleading, due to the possible strength-increase of the material caused by earlier static loads.

After the court's adjournment for lunch, Sir Lionel resumed his opening by referring to the practical side of metal fatigue. "Once you know how to recognize fatigue," he said, "you can in fact actually trace the break-up of a structure to the point where the fatigue failure actually occurred." Evidence in the R.A.E. report, he went on, indicated fairly clearly that the point where the failure in the Elba Comet occurred was near the A.D.F. rear window. This failure bore a marked similarity to that of the Comet tested to failure at Farnborough, which occurred at a forward side window after a considerably longer "life"—in this case, a simulated life.

Giving details of the Farnborough tests, Sir Lionel stated that the pressure conditions could be reproduced by water instead of air, and the flying conditions had to be reproduced artificially. The failure occurred after 5,546 total pressurizations, i.e., after a total equivalent life (including actual flying) of 9,000 flying hours. "You will be told by Sir Arnold Hall that the 3,681 hours of the Elba Comet and this 9,000 hours cannot be regarded as outside the realm of the possible spread of the fatigue trouble . . . 3,681 is within what is called the reasonable scatter, and the 2,701 (of the Naples Comet) is also said to be within that area."

The final part of Sir Lionel Heald's opening for the Crown consisted of the quotation of some of Sir Arnold Hall's conclusions from the R.A.E. report on the Comet investigations. With the object of being entirely non-controversial in opening, Sir Lionel omitted "the part of it which dealt with certain other subsidiary matters, because there may be some controversy about those. . . ."

Discussing the Elba accident, the section of the report first quoted by Sir Lionel gave the sequence of the Comet's structural failure, already outlined, based on the examination of wreckage.

The report continued: "The flight plan which the aircraft was following would have brought it to an altitude of about 30,000ft at the time of the accident. Supporting evidence showing that the break-up occurred at this height is as follows. Metallurgical examination of the burnt centre-section shows that the fire was burning for about three minutes, and calculations and model tests confirm that the time of descent of the centre-section from 30,000ft altitude would be of this order. Tests on models confirm that a 'break-up' of the kind outlined, at this altitude, would produce on the ground a pattern of wreckage similar to that found on the sea-bed near Elba, and that the motions of the larger parts would be of the type which would lead to impact with the sea in the directions which are thought to have occurred in the accident."

"To produce a violent disruption of the pressure cabin, there must have been a structural failure under normal flight loads (including the internal pressure load), or the internal pressure must have been raised to an abnormally high value, or a failure must have been induced due to the development of abnormally high tail-loads."

An investigation had shown that the fatigue life of the cabin was relatively short. "The failures produced on test originate at points of concentration of stress near the corners of 'cut-outs' in the structure of the cabin which accommodate windows and hatches. The general character of the concentration of stress is similar at each cut-out. Evidence from the wreckage suggests strongly that the initial failure in the accident occurred at one of these stress concentrations (Elba Comet) and was of the same nature as the fatigue failures (Comet tested at R.A.E.). It is shown in the Comet tested at Farnborough that, quite apart from the direct evidence from the wreckage, the test results can be interpreted as meaning that fatigue failure of the cabin, at the age of the aircraft involved in the Elba and Naples accidents, is possible. A failure of the type envisaged would cause the violent disruption of the centre fuselage which occurred in the accident."

There was no evidence, the report went on, of the development of abnormally high internal cabin pressure, either by mis-operation of the ventilation and pressurization system, or by explosion, neither was there evidence of loss of control.

"We have formed the opinion that the accident at Elba was caused by structural failure of the pressure cabin, brought about by fatigue. We reach this opinion for the following reasons:—(1) the low fatigue-resistance of the cabin has been demonstrated by the test described, and the test result is interpretable as meaning that there was, at the age of the Elba aeroplane, a definite risk of fatigue failure occurring. (2) The cabin was the first part of the aeroplane to fail in the Elba accident. (3) The wreckage indicates that the failure in the cabin was of the same basic type as that produced in the fatigue test. (4) This explanation seems to us to be consistent with all the circumstantial evidence. (5) The only other defects found in the aeroplane were not concerned at Elba, as demonstrated by the wreckage.

"Owing to the absence of wreckage, we are unable to form a definite opinion on the cause of the accident near Naples, but we draw attention to the fact that the explanation offered above for the accident at Elba appears to be applicable to that at Naples."

Sir Lionel commented: "I believe that I am right in saying that, as regards Elba, Sir Arnold Hall's explanation or reconstruction of the accident will be generally acceptable. As regards Naples, of course, we are in the area of surmise."

LORD BRABAZON ON INVENTIONS

A VAST field of evolution and discovery was reviewed with remarkable conciseness—and wit—by Lord Brabazon of Tara when he delivered the Morgan Morgan Foundation Lecture to the Institute of Patentees in London on October 20th.

After speaking of various milestones in discovery, beginning with the invention of the wheel, the lecturer came to modern times, and here he drew a forthright comparison between progress in the evolution of the motor car and the aeroplane respectively. He showed that in many ways automobile design had really made very little progress in over 50 years and that in some respects—he cited the abandonment of magneto ignition—designers had taken retrograde steps.

In aeronautics, on the other hand, there had been staggering advances. Design had never been stagnant; there was always something arising to upset existing notions. As "an aeroplane that showed more advance than any other" Lord Brabazon cited the Douglas DC-2, with its stressed-skin wing, variable-pitch airscrews, flaps and retractable undercarriage.

Next he referred to the gas turbine; and now, he said, we were hearing of jet levitation. This last development interested him profoundly, for he could not believe that the future of flying lay in a world strewn with two-mile runways; it was not logical for aeroplanes to touch down—as they did every day, admittedly with few accidents—at over 100 m.p.h. Jet levitation promised advantages of the helicopter with the speed of the fixed-wing aeroplane.

OFF THE BEATEN TRACK

A SERIES of four short lectures were given at an Institute of Navigation meeting in London on October 20th to an audience consisting primarily of cadets from nautical colleges and training ships, Sea Cadets and Sea Scouts. The lectures, under the general heading *Off the Beaten Track*, dealt with navigation in ocean racing, low-level map-reading, navigating a midget submarine, and interplanetary navigation; and they were delivered respectively by Capt. (E) J. H. Illingworth, R.N., W/C. E. W. Anderson, O.B.E., D.F.C., A.F.C., Cdr. C. G. Place, V.C., D.S.C., R.N., and Dr. J. G. Porter.

W/C. Anderson introduced each of the speakers, his own subject being demonstrated in the R.A.F. instructional film *Nought Feet*, showing the planning and execution of a low-level attack from Cherbourg Peninsula on Cheltenham.

Dr. Porter briefly exposed some of the navigational problems to be expected in interplanetary travel. Particularly he mentioned the very high speeds (initially 6.95 miles/sec) which would have to be absolutely accurately maintained, as would the course (plus or minus seconds of arc). It was virtually impossible, he said, to take sights of heavenly bodies in space and plot position from them accurately and quickly enough. Finally, the longitudinal axis of a space vehicle did not necessarily bear any relation to its direction of movement, and steering was therefore a special problem. In space, the words "up," "down," "left" and "right" lost their meaning.

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The Beechcraft and Safir on the deck of the 600-ton sealer (see letter "Aircraft in the Antarctic").

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

CORRESPONDENCE

Aircraft in the Antarctic

WHEN reading the interesting article "Antarctic Air Exploration" in your issue of October 1st, I was rather surprised to find that the only aerial activity mentioned for the Norwegian-British-Swedish Antarctic Expedition, 1949-1952, was the participation of the two Austers from the R.A.F.

The uninformed reader may get the impression that the aerial survey carried out during the expedition, which covered 500,000 square kilometres of mostly unknown land, was made with the Austers. Since, also, the British account of the expedition (*The White Desert*, Chatto and Windus, London, 1954) may give the same misleading view, some facts about the flying activities during this first international Antarctic expedition may be of interest.

Due to the international status of the expedition it was agreed that a British air unit should join the expedition during the first south summer 1949-1950, a Norwegian unit should join during the second summer 1950-1951 and a Swedish unit during the last summer 1951-1952. The British unit was to help the expedition to find the way through the pack ice and to find a suitable landing place. The limited range and load capacity of the Austers makes it hard to believe that anyone would expect them to carry out actual surveying flight.

The R.A.F. unit fulfilled its task in nine flights before arrival on the continent and played an important part in helping the expedition to find a very good landing place. After the arrival, the unit made 25 flights during four days, according to the official report of the officer commanding. Only one flight lasted for more than three hours and most of the flights were local passenger flights with members of the expedition. During one flight to the south some mountains were observed approximately 160 miles south of the base. The position of these mountains was later confirmed during another flight. The British unit went north with the expedition ship and was put on shore at Cape Town on March 7th, 1950.

The purpose of the Norwegian unit which went south in 1950-1951 was to carry out aerial surveying, primarily over the area covered by the ground parties of the expedition. The unit had bad luck with the weather and the equipment was not suitable for the severe task. The crew of the unit did a good job, however, and flew 76 hr during its term in the Antarctic, even if the photographic result did not show up as expected.

Originally, the Swedish unit was only to serve as a safety factor when the ship went south for the third and last time to bring the ground party of the expedition home after their two years on the unfriendly continent. Due to the failure of the surveying in 1950-1951, however, the leader of the expedition made a request to the Swedish Air Force that the unit should try to fulfil the surveying programme, as this was of great importance to the whole expedition.

In order to be able to carry out the surveying the unit was provided with one twin-engined Beechcraft 18R and one single-engined Saab Safir. Both planes could be operated on floats, ski or wheels.

During a period of 16 days the Beechcraft made 11 photo-mapping flights and covered an area from 3°E to 21°W and 75°S. The result was a complete survey of the mountain area in the western part of Queen Maud Land and the coast line around the north-eastern approach to the Weddell Sea. The unit found that the German maps which covered the most eastern part of this area were incorrect. The western part of the area had never been covered from the air before.

The unit went north with the expedition and was put on shore at Gando airport on Gran Canaria. After some days of inspection work the unit flew to Sweden. The aircraft were found to be in such a good condition after the expedition that they could be put into normal service almost at once.

In view not only of the work achieved by the Swedish air unit but also of the way in which the transportation problems were solved—one twin-engined and one single-engined aircraft being transported on the deck of a 600-ton sealer during three months over some of the worst ocean areas in the world—I think there is some reason to remember it when discussing the flying activities over "the white desert."

I have pleasure in sending you a photograph showing the ship with the aircraft and another showing "Maudheim airport 1951-1952," complete with air traffic control tower, work-shop tent, fuel depot and plane, the most southerly airport that year.

Stocksund, Sweden. R. v. ESSEN,
Capt., Royal Swedish Air Force,
O.C. Swedish Antarctic Flight, 1951-1952.

'Strange Resting-place": The Probable Answer

THE airscrew blade in the monastery at Batchkovo, Bulgaria, mentioned by "W.3643" in her letter (October 15th) is almost certainly that of a Sopwith triplane.

At the end of February 1917 there appeared on the Dojran front a German bombing squadron, No. 1 *Kampfgeschwader*. This formidable mobile unit had come to Hudova aerodrome from Bucharest after carrying out a bombing campaign against Rumania. Its equipment consisted of A.E.G. G.IVs, Friedrichshafen G.IIIs, some unidentified twin-engined Rumplers, one Gotha and some Halberstadt single-seat fighters.

The German aircraft made a number of bombing attacks, brushing aside British opposition offered by Armstrong Whitworth F.K.8s, and B.E.2Cs and B.E.12s. Moreover, there were only sixteen anti-aircraft guns on the whole of the British front. This situation placed in jeopardy Lt-Gen. G. F. Milne's plans for a British attack on the western shore of Lake Dojran.

He therefore wrote to Vice-Admiral Sir Cecil F. Thursby, then commanding the Eastern Mediterranean Squadron, and asked for R.N.A.S. aircraft to be placed at his disposal. At the end of March 1917, an R.N.A.S. unit known as "E" Squadron was formed; it was equipped with four Sopwith 1½-strutters—and a single Sopwith triplane.

This unit was sent to an aerodrome at Hadzi Junas behind the Dojran front. There, for a time, it combined with an R.F.C. detachment to form a unit known as the Composite Fighting Squadron. Hadzi Junas lies about 28 miles N.N.W. of Salonika and roughly 100 miles S.W. of the Rhodope Mountains.

I therefore think it highly probable that the airscrew which is now an altar-piece in Batchkovo (or was, fifteen years ago) belonged to that solitary Sopwith "three-stage flyer," the only Sopwith triplane to be used in Macedonia. (But in September 1917 a triplane was being flown by the R.N.A.S. on Mudros.)

I do not think any enemy triplane of any type ever saw service outside the French theatre of war, but perhaps Mr. A. R. Weyl will correct me if I am wrong. German (and Austrian) triplanes appeared in amazing profusion, but the greatest number in operational service totalled only 180: these were the 171 Fokker Dr.Is and 9 Pfalz Dr.Is in service in June 1918. I believe these figures included those with the *Kampfeinsitzer-Staffeln* of the German Home Defence organization, but I know of none in Macedonia.

This is a quite fascinating historical snippet, and one wonders how many similar relics of aircraft of the Great War are still preserved in other places.

Birmingham, 32. J. M. BRUCE.

IN BRIEF

Mr. Ian Mackersey ("The Circle," Meadowbrook, Old Oxted, Surrey) has undertaken to write the history of the Caterpillar Club, and is anxious to collect stories of "bale-outs" made since 1920. He would specially like to hear of life-saving parachute descents compelled by out-of-the-ordinary circumstances, of descents which ended unusually, and of any instances where two people successfully shared the same parachute.

THE INDUSTRY

Research into Packing

AS briefly recorded in this section of *Flight* last week, the new research and development establishment sponsored by Export Packing Service, Ltd., was formally opened on October 14th by Sir Edward Boyle, Parliamentary Secretary to the Ministry of Supply.

Situated alongside the main centre of the E.P.S. organization at Sittingbourne, Kent, the building houses laboratories, workshops, test houses and drawing offices on the ground floor and administration offices, additional laboratories, a conference room and cinema theatre on the first floor.

Investigation of packing and preservation problems will form the major occupation of the new centre, the test houses and laboratories of which account for an area of 5,500 sq ft. The main test area has a granite-filled concrete floor into which two 20ft square concrete blocks have been sunk to a depth of 3ft. One will be used as a drop-test area and the other will support vibration-test equipment.

Other major items of equipment include an immersion tank and a tropical testing chamber. Smaller tropical test chambers are available for tests of packagings against moisture penetration. Work on this side of the establishment comes under the direction of the chief research engineer, Dr. Noel Coates, Ph.D., B.Sc.(Eng.). Mr. D. G. Miller, the chief designer, is in charge of the designs and drawing office sections and prototype shop.

While the designs section will continue to devote itself chiefly to the solution of day-to-day specific packing and preservation problems, Dr. Coates is to embark on a programme of pure research, which E.P.S. summarize as follows:—

(1) Dynamic testing of cushioning and suspension media used in protective packing in order that reliable data may be built up for design reference. (2) Examination and testing of equipment to assess fragility and establish definite safety factors. (3) Institution of tests revealing and recording the effects of hazards stemming from climate, transport, storage, corrosion, vibratory and sudden shocks. (4) Design and development of new instrumentation, both electrical and mechanical, better to simulate the effects of transportation and long-term storage. (5) Investigation of new materials and techniques and their application to packing.

At the rear of the building is space for a permanent helicopter landing field. One of the company's customers has already used it: a Bristol Sycamore recently arrived under its own power for subsequent dismantling and packing.

Export Packing Service, Ltd., whose founder and managing director is Mr. Rex Boucher, M.B.E., employs over 2,000 people at its four stations; apart from the headquarters at Sittingbourne, there are units at Cardiff, Banbury and Merthyr Tydfil.

Lodge Jubilee

THIS week the firm of Lodge Plugs, Ltd., celebrates its golden jubilee, for it is almost 50 years ago since the two sons of the great scientist, Sir Oliver Lodge, put into production a newly patented system of high-tension ignition based on their father's research. Nine years later they joined forces with the firm's present chairman, Mr. Bernard Hopps, who was manufacturing his own Mascot plugs in Rugby.

The company produced its first aircraft plugs in World War I, and very soon almost its entire output was taken over for use in Rolls-Royce engines.

In the Second World War, plugs for British Service aircraft accounted for three-quarters of the company's production. At this period Lodge introduced platinum-electrode plugs, which increased the service life from 75 hr to over 300 hr, and all Hurricanes, Spitfires and Lancasters were fitted with them. Soon there was a still greater demand for Lodge plugs when they were ordered by the American 8th Air Force as servicing replacements for their aircraft based in this country.

For Economical Fettling

SPECIALISTS for many years in the design and production of flexible-shaft-driven equipment, the firm of Flexible Drives (Gilmans), Ltd., Smethwick 41, Staffs, have also produced a wide range of tools for use with it, and among the most important of these are burs for fettling. Made of steel, such tools will operate efficiently on orthodox materials, but their use on such alloys as heat-resistant and stainless steels, widely used in gas turbine work, shortens their efficient life.

Gilmans, therefore, have introducted a tungsten carbide bur, which, moulded by the sintering process instead of being ground from the solid, is stated to offer the advantages of tungsten carbide at a lower price. Known as "Segburs," these tools—which, incidentally can be reground by hand—are already available in a wide variety of patterns.

Mr. W. E. Watson, M.B.E., who has been appointed works director of Smiths Aircraft Instruments, Ltd. He served his apprenticeship with Henry Hughes and Son (now Kelvin and Hughes, of the Smiths Group), and in 1931 was responsible for the production of the Mk 1 auto-pilot. He has been works manager at Smiths' Cheltenham factory since 1940.

Portable Stroboscope

A RECENT addition to the range of instrument and electronic equipment marketed by Davis, Wynn and Andrews, Ltd., of Cheltenham, is a hand-held stroboscope. Known as the Model PSC2, it is designed for the examination of moving machinery where the frequency is greater than the persistence of vision, i.e., 20 c.p.s. (1,200 r.p.m.) and upwards. Light flashes of short duration and variable frequency enable rotary or reciprocating motion to be apparently "stopped" or slowed down.

All necessary circuitry is enclosed in the instrument, which is connected to a 230-volt mains supply by as long a lead as is needed. For prolonged examinations the handle may be unscrewed and the instrument mounted on a camera tripod, for which there is a standard threaded bush.

Three frequency-ranges are provided—900-2,600, 2,600-7,000 and 7,000-15,000 r.p.m.—and the thumb-operated dial is calibrated to an accuracy of approximately two per cent. The instrument weighs 3 lb 9 oz.

A small vibrating-reed calibrating unit can be supplied, if desired, to enable the dial markings to be checked against the mains frequency.

IN BRIEF

Jet Tanks, Ltd., announce that their capital has been increased from £100 to £10,000.

* * *

At the recent annual general meeting of Newton Brothers (Derby), Ltd., makers of aircraft and other electrical equipment, Mr. F. V. Pipe, O.B.E., A.M.I.E.E. (chairman) reported a record year's business in which export work had amounted to 21 per cent of the total.

* * *

An ingenious electric soldering iron, making use of 18-gauge wire solder fed forward to the tip by pressure on a thumb-rest, has been developed by C. I. Casey (London), Ltd., 49 St. James's Street, London, S.W.1. Known as the Solo solder tool, it may be operated (taking 7 amp) from a six-volt car battery, or from A.C. mains through a small transformer.

* * *

The Scientific Instrument Manufacturers' Association is to hold an exhibition of electronic production aids, under the title "Electronics at Work," at Birmingham Chamber of Commerce Hall from November 23rd to 25th. Admission is by ticket, obtainable on application from the Association at 20, Queen Anne Street, London, W.1, or, in Birmingham, from the Chamber of Commerce, the Engineering Centre, or the city Information Department.

* * *

Prof. Laerum, who is Professor in Highway and Railroad Construction at Trondheim University of Technology, and Technical Director of the Constructional Department of the Norwegian Ministry of Defence, has been in charge of the construction of airfields and other NATO defence work in Norway. He recently arrived in this country on a visit, one purpose of which was to enable him to study jet-resistant jointing and surfacing materials. He was accompanied by Mr. Aasrud and Mr. Saxegaard, executives of the firm of Fjeldhammer Brug, who are Norwegian distributors for the products of Expandite, Ltd., of London, N.W.10.

* * *

The death was announced, on October 13th, of Mr. Harold Darnborough, former chief accountant of The Bristol Aeroplane Co., Ltd. Mr. Darnborough joined the company as chief accountant in June 1936; he held the post through the expansion programme before the war and through the war years, when he was responsible for much of the financial side of organizing the "shadow" production of Bristol aircraft and engines. Persistent ill-health eventually forced him to relinquish the post of chief accountant in July, 1949, but he remained with the company in an advisory capacity until continued ill-health compelled his retirement shortly afterwards, at the age of 55.

Problems of flight

FOLDING WINGS

Folding wings have been used by beetles since evolution was young. Man, in the carrier-based aircraft, has faced only recently the problem that Nature solved so long ago.

There are nearly as many different reasons for folding wings as there are different kinds of beetle — and beetles, with their 250,000 species, are the largest order in the animal kingdom. Their habits vary widely. Some no longer fly; some never did. Those that do have heavier bodies than any other flying insect, because of their thick plates of protective armour. (Some also have enormous jaws: those of the male stag-beetle illustrated may be for fighting other males during the mating season, or perhaps for scraping plant-shoots to get at the sap.)

This great weight demands large wings. Hence Nature's problem. For many beetles burrow into the earth; many fight; many find their food or their safety in cracks in wood or chinks in stone. Unfolded wings would make all this impossible. And the beetle's wings are fragile. To keep himself airworthy he has to protect them under armoured covers. (These covers are actually his fore-wings, specially adapted for this special task.)

As in the crowded turmoil of the insect world, so in the tight space of an aircraft carrier. Man has taken yet another leaf out of Nature's great book—has found to yet another of his problems another time-honoured answer.

Pilots whose planes do not need the refinement of folding wings—because they land them at any of Britain's airfields—value the excellent and helpful service of the Shell and BP Aviation Service.

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CIVIL AVIATION

WORLD HELICOPTER MEETING

THE first meeting of the I.A.T.A. Helicopter Working Group, intended to launch an international effort to ease the introduction of helicopters into regular commercial service, will take place in Montreal from November 11th to 13th. The Working Group will include experts from airlines and local air services of three continents who have already begun helicopter operation, as well as from companies planning their introduction in the near future. Attendance at the Group's meetings is not restricted to I.A.T.A. members.

Helicopter problems will be considered by the Group in two stages: as they arise from the operation of current single-engined machines under V.F.R.; and as they are expected to develop in the operation of future multi-engined types under I.F.R.

The new Working Group follows the I.A.T.A. Helicopter Symposium at Puerto Rico in May 1953, at which designers, manufacturers, operators and government agencies conferred. In announcing the Group's first meeting, the Director-General of I.A.T.A., Sir William P. Hildred, said:

"The Puerto Rico symposium was the first occasion in history on which all parties concerned with a revolutionary new means of transport have had a chance to consider their mutual needs and desires in advance of its general introduction. We believe that the symposium has helped to co-ordinate the efforts of all countries and all interests concerned to develop the helicopter and the various aids and rules it needs to the point where it can be brought into public service as early, efficiently and economically as possible.

"The I.A.T.A. Helicopter Working Group carries this effort a step farther. We hope it will provide an effective machinery for analysing the problems of helicopter operations in the light of all the best information available, and for recommending the best possible measures to encourage the full development of its potential usefulness to the public."

Among the operators expected to take part in the November 11th meeting are British European Airways, Sabena, Philippine Air Lines, Eastern Air Lines, Helicopter Air Services (Chicago), K.L.M. Royal Dutch Airlines, Los Angeles Airways, Mohawk Airlines (New York), National Airlines, New York Airlines, Okanagan Airways (British Columbia), Port of New York Authority, Trans Canada Air Lines and Trans World Airlines.

AUGUST ACTIVITY AT U.K. AIRPORTS

THE total number of aircraft movements at M.T.C.A. and other U.K. aerodromes during August was 73,105, compared with 69,504 in August last year. Of these, 32,901 were transport aircraft movements, a ten per cent increase over the August 1953 figure. The total number of passengers handled increased by 13 per cent to 662,729.

Freight on and off-loaded amounted to 15,157 short tons—an increase of 34 per cent which was due mainly to increases in cross-Channel vehicle ferry traffic. Post Office mail set down and picked up during the month increased slightly from that of last August to 1,132 short tons.

London and Northolt Airports together handled 299,362 passengers (out of the total for all London area aerodromes of 331,688)—a ten per cent increase. At London Airport there were 6,607 transport aircraft movements and 208,847 passengers were handled, both increases of some 30 per cent. The continued transference of services from Northolt to London Airport prior to Northolt's closure was not unnaturally reflected in that airport's figures also: aircraft movements and passengers handled decreased by 28 per cent and 19 per cent to 3,470 and 90,515 respectively. Airports other than London at which passenger traffic increased considerably over that for August 1953 included Jersey, 73,050 passengers (15 per cent increase); Manchester (Ringway), 44,065 (16 per cent); Glasgow (Renfrew), 37,156 (19 per cent); Liverpool (Speke), 18,906 (14 per cent); Birmingham (Elmdon), 16,280 (30 per cent); and Edinburgh (Turnhouse), 8,948 (42 per cent).

Elmdon, Birmingham's airport, is among those at which Viscounts have now become familiar. Here, a Belfast-bound Viscount of B.E.A. taxies out past the distinctive terminal building.

B.E.A. TRIES CABIN LOUDSPEAKERS

BRITISH EUROPEAN AIRWAYS are at present experimenting with public-address systems in their Viscounts, and during a flight in one of these machines last week we were able to hear some results. On several occasions in the past *Flight* has written of the desirability of keeping passengers informed of the progress of the flight, of the weather and of places and features of particular interest which may be visible below.

The unusual quietness of the Viscount is, of course, most helpful, and all the passengers can hear reasonably well without the need for an excessive number of roof speakers, without the volume being such as to distort speech or accentuate background noise, and without those seated nearest each speaker being deafened in order to allow more distant passengers to hear. Though the particular installation to which we listened was satisfactory, it still left a little to be desired in regard to background hum.

It was apparent that instruction and experience in using the equipment is important. The way in which the microphone is held and the pitching of the voice obviously had a great deal to do with reception. Whereas the captain came through clearly and his crisp and concise remarks were indicative of R/T. experience and discipline, the melodious and drawing-room tones of the stewardess were soothing but almost undecipherable. B.E.A.'s chief executive himself said a few words over the system, and reproduction was quite good, though not so good as when the captain spoke. Our contention that microphone experience and speech training are important is perhaps borne out by the fact that the B.B.C. one o'clock news was received remarkably clearly when flying at 20,000ft and some 300 m.p.h.

It may be added that the majority of American operators have used address systems in their aircraft for some time past but that—judging from our own experience—few seem adequately to have instructed their cabin staffs in their use. While in most instances the captain comes through clearly above engine noise, the stewardess frequently does not. Pitch and loudness of voice are not necessarily the deciding factor, for a high-pitched voice would normally come through better than one that is low pitched.

AIRWORK'S ATLANTIC PLANS

MARCH 1st, 1955, has been announced as the inaugural date of Airwork's scheduled all-freight transatlantic service to New York and Montreal, which will be operated at an initial frequency of two overnight flights per week. Delivery of the three Douglas DC-6As now on order and destined for this route will be made in January, 1956; in the interim, DC-4s will be used. The company's North American president of the service, which is to be called "Airwork Atlantic," is Mr. John E. Muhlfeld, until recently general sales manager of Pan-American Airways.

The aircraft used on this route will fly from London Airport, where a new freight shed for the company's use is now under construction. Additional loading points in Europe will be Frankfurt, Milan, Zurich and Geneva, while applications for stops at Manchester and Shannon in addition has been made.

British European Airways will receive a total of 26 Viscount 701s, the first 20 of which have been in service some months. After delivering batches to Air France, Aer Lingus and Trans-Australian Airlines, Vickers are again supplying B.E.A. This is G-ANHA "Anthony Jenkinson," delivered on October 19th.

CIVIL AVIATION . . .

AER LINGUS YEAR

DURING the financial year 1953-4, Aer Lingus, the Irish National Air Line (40 per cent owned by B.E.A.) incurred a net deficit of £62,663, compared with a deficit of £85,718 for the previous year. The company increased its share of the dwindling total Anglo-Irish sea and air traffic, and passenger traffic was up by three per cent and freight by no less than 28 per cent—to 5,071 short tons. The latter was largely a result of the use of four Bristol 170s which, together with 12 DC-3s made up the Aer Lingus fleet during the period reviewed; the four Viscounts did not begin operations until April of this year. The company's operating results show that the gap between the break-even and achieved load factors still exists, although it is now but two per cent (between 67.1 and 65.0 per cent). A total of 7,416,000 revenue ton-miles were performed, and 297,081 passengers were carried.

BRITANNIA FATIGUE TESTS

A BRISTOL Britannia will be among the first civil aircraft to undergo fatigue tests at R.A.E., Farnborough, similar to those recently applied to a Comet in connection with the Establishment's investigations of the causes of the two Comet accidents earlier this year. Some months ago, the Bristol Aeroplane Company began discussions with the Ministry of Supply, in which Britannia testing in this way was suggested.

It was stated last week that arrangements had now been made for carrying out an agreed programme of tests. A representative of the Bristol company emphasized that these tests were confirmatory and the company were confident of their satisfactory outcome. It was not expected that they would cause any delay in production or in the date of introducing the Britannia into service.

A.R.B. GUIDE TO AIRWORTHINESS

RECENTLY revised in the light of the Air Navigation Order, 1954, and the Air Navigation Regulations, 1954, is the A.R.B. handbook No. 1, entitled *Notes on the Regulations Covering the Airworthiness of Civil Aircraft*. This year's Orders and Regulations were the first complete re-issue since 1949 and so contain all the amendments promulgated since then. The Board's handbook continues to do a useful job in presenting the essentials of the airworthiness regulations in a simple and clear manner.

Among the subjects with which the handbook deals are registration, identification and markings, classification, the issue of various types of certificate of airworthiness, validation of foreign C.s of A., modifications to aircraft, instruments and equipment to be carried by U.K. aircraft, weighing and c.g. determination, certification by licensed engineers, approval of airscrews and the approval, installation and carriage of radio apparatus. It is published by the Air Registration Board, Brettenham House, Strand, London, W.C.2, and costs 2s 6d.

S.A.S. TRANS-POLAR FLIGHTS BEGIN

THE Scandinavian Airlines System Arctic service between Europe and California is to be inaugurated on November 15th. The first flight of the regular twice-weekly service will carry members of the Scandinavian royal families as guests of honour, and will take 26 hours from Copenhagen to Los Angeles —six hours less than the conventional North Atlantic route. The saving in distance flown is about 1,250 miles. The route from Copenhagen *via* Greenland and Winnipeg to Los Angeles will be connected with major Western German airports, and will be operated with Douglas DC-6Bs and later DC-6Cs. By agreement with the North American authorities, it is reported, fares will not be competitive with the North Atlantic route until U.S. airlines also are flying the Arctic route, when a fall in fares is certain.

VISCOUNT DAMAGED

DISCOVERY-CLASS Viscount *Robert Falcon Scott* is now at Ciampino Airport, Rome, after failure of the port main undercarriage during a precautionary landing. The Viscount, with 31 passengers and six crew, was on flight BE 130 from London to Istanbul, and had arrived at Rome at 3.40 p.m. During the climb away from Rome, the captain (Capt. Wilson) found the port indicator showing red and, although the crew later decided that the gear was up and locked, he elected to return to Rome rather than put down at a secondary field in the worsening weather.

Touching on all six wheels, the Viscount landed normally; but the port gear collapsed and the aircraft slewed off the runway, damaging the port wing, flaps and airscrews. There was no injury to passengers, crew, baggage or freight, and the service was continued by a relief aircraft.

MALTON EXPANSION

WORK is expected to begin early next year on the modernization and extension of Malton Airport, Ontario. The development plan, covering a 20-year period at a cost of $22,000,000, was recently announced by Mr. J. B. Baldwin, Canada's deputy Minister of Transport. The installation of dual runways and an extension of the runway area are included in the scheme. The Transport Department's overall plan for the extension of Canadian airports, estimated to cost a total of $75,000,000, includes work at Dorval, Gander and Winnipeg, in addition to Malton.

VISCOUNTS FOR HONG KONG

ANOTHER order for the Vickers Viscount was announced last week with the signing of a contract with Hong Kong Airlines for one 700D, and an option on a second machine. This aircraft is, incidentally, the first to be ordered with slipper tanks.

Production of Viscounts is going well according to plan, and slightly late delivery of the T.A.A. and T.C.A. first machines is not significant. These aircraft have a new four-tank fuel system to meet customers' requirements, and the thorough testing of the first machines completed has delayed deliveries by a few weeks. However, the aircraft which follow are up to schedule, and there is no reason to suppose that later deliveries or the planned times for introduction of Viscounts to service in Canada or Australia will be affected.

EMERGENCY AIR FREIGHT

FREIGHT traffic between Holland and the United Kingdom rose well beyond most operators' carrying capacity when the dock strikes virtually closed the Port of London. Chartered aircraft were busy carrying butter, margarine, cheese and Dutch liqueurs, while the scheduled airlines, particularly B.E.A., reported far more requests for freight transport than they could accept. B.E.A.'s single Pionair Leopard freight-carrying service worked overtime transporting cocoa, pepper and biscuits. K.L.M. also reported an increase of 20 per cent in their freight traffic between Amsterdam and London.

BREVITIES

THE former T.C.A. hangar at Toronto Airport, Malton, has now been taken over by the Genaire Company of St. Catharines, Ontario. The hangar, which has a usable area of 48,000 sq ft, will be used for the maintenance, repair and overhaul of commercial aircraft, in addition to the leasing of hangar space and services to operators of executive-class aircraft.

* * *

The 500th scheduled all-cargo flight on K.L.M.'s Amsterdam-New York route left Schiphol Airport on October 17th. This scheduled freight service was started in May, 1948, and the original frequency of one flight per week has now been raised to three, operated with DC-4s and DC-6As.

* * *

An agreement has been concluded between Iberia and Lockheed Aircraft Service-International to cover the maintenance and overhaul of the Spanish airline's three Lockheed Super Constellations at present in transatlantic service. This work by L.A.S.I. is being performed at New York International Airport, Idlewild, on a fixed price per flying hour basis.

* * *

A B.E.A. Viscount, *Sir Edward Parry*, set up a new record for the flight from Zurich to Vienna on October 19th with an average speed of 285 m.p.h. The aircraft, piloted by Captain Alan Turner, and carrying 26 passengers, completed the 600-km flight in 1 hour, 13 min: scheduled time for the Zurich-Vienna leg is 1 hour, 45 min.

* * *

B.O.A.C. point out that, on the Monarch Stratocruiser service from New York to Cairo, *via* London and Frankfurt (mentioned in October 15th issue), local traffic can be carried between London and Frankfurt and between Frankfurt and Cairo, and return.

* * *

A £30,000 development scheme for Southend Airport was approved by Southend Town Council on Thursday, October 14th: work on the foundations for some of the airport's new buildings began the following day. A considerable traffic increase next season is envisaged.

* * *

A most useful M.T.C.A. civil aviation information circular is No. 131/1954, *The Effect of Thunderstorms on Aircraft Operations*, which records up-to-date American and British experience of the hazards of flight through thunderstorms.

* * *

The first application by Britavia to the Air Transport Advisory Council is for a 10-year licence to operate a thrice-weekly all-freight service between London and Perth, Australia, with pressurized Hermes aircraft.

* * *

Some 3,000 people attended the second annual Airlines Ball at the Royal Albert Hall, London, on October 15th. The orchestras of Geraldo and Teddy Foster provided the music, and guest of honour was Mr. A. J. Pegg, O.B.E., chief test pilot of Bristols. This joint effort by the two Corporations, the Independents and foreign operators is already well-established as an important occasion in the social calendar: the organizers deserve wholehearted praise for a most enjoyable evening.

FROM THE CLUBS

LOOKING back on the first summer's operations, the Surrey Flying Club feels moderately satisfied with the results achieved since the move to Croydon on May 8th last. Since that time 86 new flying members have joined, bringing the total flying membership to 161. Flying hours for August and September were 220 and 163 respectively. Permission has been granted to erect the proposed clubhouse and negotiations are in progress with the Kemsley Flying Trust for funds to commence building operations. The club's first social event, a dance, will be held on Friday, November 26th, at the Aerodrome Hotel, Croydon.

ROCHESTER Flying Club held its annual dinner-dance at the Tudor House, Bearsted, near Maidstone, on October 15th. There were not quite so many guests this year as last, but the function provided an excellent evening's entertainment. The principal guests were Rear-Admiral M. S. Slattery, chairman of Short Brothers and Harland, and Mrs. Slattery, Admiral Sir Geoffrey Oliver, C-in-C. the Nore, and Lady Oliver; Admiral Sir Albert L. Poland, and Lady Poland; G/C. P. H. Hamley, station commander, R.A.F. West Malling, and W/C. T. C. Chambers, manager of Short's factory at Rochester, and Mrs. Chambers. The dance was organized by the club's social committee under the chairmanship of Mr. C. Blanchard.

TWIN conversions are now available at the Elstree Flying Club, with the addition of Gemini G-AJTL to the club's fleet of Austers and Hawk Trainers. A series of briefing pamphlets is being prepared for the use of student pilots, and a bonfire party will be held next Thursday, November 4th.

HIGH winds and bad weather at Yeadon restricted flying during the last two months; nevertheless a healthy number of new pilots qualified. In August, 193 hours were flown, during which two first solos were made and five P.P.L.s gained. Four first solos were flown during September, two P.P.L.s obtained, and 172 flying hours logged.

THE APPOINTMENT of Mr. Alfred S. Burridge as secretary and resident instructor of the Ulster Flying Club at Newtownards has been announced. He succeeds Mr. George Wynne-Eaton who was killed in a car accident last July. Mr. Burridge was formerly an instructor at the Redhill (Surrey) Flying Club. He is an ex-R.A.F. officer with more than 7,000 flying hours—including 5,000 on instructional duties. In the absence of a resident instructor at Newtownards, where the Ulster club now has 185 members, W/C. C. W. Lindsay, A.F.C., the C.F.I., has been carrying out the training programme single-handed.

Mr. Alfred S. Burridge.

FORTHCOMING EVENTS

Oct. 29. Institute of Navigation: Annual general meeting.
Oct. 29. Aerauto Association: Dinner and dance.
Oct.28-29. Institute of Welding: Presidential address by Mr. R. G. Braithwaite, M.I.C.E., and discussions on papers dealing with welding and materials.
Oct. 29. R.Ae.S. Graduates' and Students' Section: Reception and dance.
Oct. 30. British Interplanetary Society: 21st Anniversary celebrations (Provisional Yorkshire branch).
Oct. 30. S.L.A.E.: "Developments in Aircraft Pressurization," by F. W. Michael.
Nov. 2. R.Ae.S. Section Lecture: "Design of Small Jet Engines," by H. S. Rainbow.
Nov. 4. R.Ae.S. Main Lecture: First Sir George Cayley Memorial Lecture, by Capt. J. L. Pritchard, C.B.E. (at Hull).
Nov. 4. R.Ae.S. Graduates' and Students' Section: Film—"The German A.4 Rocket (Operation Backfire)."
Nov. 4. Institute of Metals: "Trends in Metallurgy," by Prof. A. G. Quarrell, Ph.D., D.Sc.
Nov. 6. British Interplanetary Society: "Medical Aspects of Flight above the Atmosphere," by Col. P. A. Campbell, U.S.A.F.
Nov. 6. British Interplanetary Society (Midlands branch): "Radar and Space Travel," by J. Nicoll.
Nov. 10. Radar Association: Talk on production of B.B.C. television film series, "War in the Air," by G/C. P. Dorte and J. Elliott (at Lime Grove Studios).
Nov. 10. Institute of Transport: Anniversary luncheon.
Nov. 11. R.Ae.S. Main Lecture: "Boundary Layer Control," by Dr. G. V. Lachmann, F.R.Ae.S.
Nov. 12. Helicopter Association: "Helicopter Production," by E. J. Boulger.
Nov. 13. R.A.F. College, Cranwell: Soccer v. R.M.A., Sandhurst.
Nov. 16. R.Ae.S. Section Lecture: "Uses of the 'Ace' Computor," by Dr. E. T. Goodwin.
Nov. 17. R.Ae.S. Graduates' and Students' Section: "Bird Flight and the Aeroplane," by Capt. J. L. Pritchard, C.B.E.
Nov. 19. R.A.F. College, Cranwell: Boxing v. R.A.F. Officers.

R.Ae.S. Branch Fixtures (to Nov. 22): Nov. 2, *Glasgow*, "Transonic Flight," by M. J. Lithgow. Nov. 3, *Luton*, film and discussion evening. Nov. 4, *Brough*, Main Lecture (see above); I.O.W., annual dinner. Nov. 8, *Henlow*, "Schneider Trophy Races and Their Influence on Aircraft Design," by G/C. L. S. Snaith; *Bristol*, "Exploration of Space," by A. C. Clarke. Nov. 9, *Belfast*, "New Materials for Aircraft Construction," by G. O. Jones. Nov. 18, I.O.W., junior members' evening. Nov. 19, *Belfast*, annual dinner; *Brough*, annual dinner dance. Nov. 22, *Henlow*, "The Aeroplane and its Engine," by A. Cdre. F. R. Banks.

THE GATWICK SCHEME

"Overflow" for London Airport: Government's Plans Announced

THE Government have decided, after full consideration of the report of the Public Inquiry into the proposal to develop Gatwick Airport, that this development shall proceed forthwith. This was announced in the House of Commons on October 20th by Mr. John Boyd-Carpenter, Minister of Transport and Civil Aviation.

A White Paper issued on the same day refers to a Government intention, announced in July 1952, of developing a new civil airport at Gatwick. Briefly, the reasons were that the continuous growth of traffic would soon make it impossible for London Airport to handle the number of aircraft operating into London in all conditions. After examination of a large number of possible sites, Gatwick was selected as being, on balance, the best site for a second main civil airport to serve London. Understandably, as the White Paper remarks, local opinion was disturbed by this proposal, and in the light of views expressed locally the Government felt it proper to re-examine the matter. In the course of re-examination the Minister of Housing and Local Government set up a Public Inquiry under Sir Colin Campbell; this reported on June 24th of this year, and the report was presented by the Minister to Parliament in July.

In the light of the report, the Government gave further detailed consideration to the question, and specific points referred to by Sir Colin Campbell are taken up in the White Paper. It is stated that

> "The problem of control of civil flying in the relatively crowded air of South-Eastern England is a very difficult one, and the present system of airways has been most carefully designed to facilitate safe and speedy handling of aircraft and to keep civil aircraft out of danger from military and other flying. The Government have been into this complex question again, but find themselves forced to the conclusion that changes in the present air traffic control arrangements in Southern England could not be made without a sacrifice both of safety and efficiency of operation."

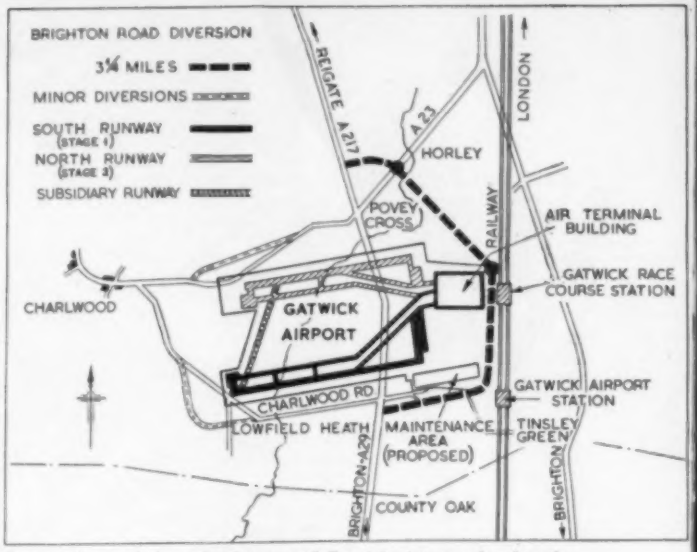
In the matter of weather, the Government were advised that there was no evidence of any kind to indicate that visibility in winter at Gatwick was worse than that at any other airport within roughly the same distance from London. The Director of the Meteorological Office consulted the chairman of the Meteorological Research Committee, who confirmed the view that the visibility observations at 9 a.m. at Gatwick in winter did constitute an indication of the weather to be expected at night. He also confirmed that the slopes of the ground surrounding the site were so slight that they did not increase the likelihood of fog.

Sir Colin Campbell had drawn attention to the criticism that the airport, as planned, could not be extended, should that prove necessary. In fact, a runway 7,000ft long was adequate for all aircraft at present using London Airport, with the exception of the Stratocruiser—adequate, indeed, for all future aircraft, so far as could be foreseen. If, however, it should prove necessary to lengthen the runway, the Government was satisfied that there was room to do so without "serious inconvenience to the public." Concerning the Stratocruiser, the White Paper runs:

> "When fully loaded, this aircraft needs an abnormally long runway for take-off. This does not apply to landing, and in any event Stratocruisers would only use Gatwick on diversion when the aircraft, having used most of its fuel, would be light and could land easily. The aircraft would then fly light to London Airport, which is the normal starting point for Stratocruiser services. If, exceptionally, a Stratocruiser should need to take off for a trans-atlantic flight with a full load of passengers from Gatwick, it would (as is normally done now) land at Prestwick or Shannon for refuelling. It could thus take off with a relatively light fuel load, and for this the 7,000ft runway is more than sufficient."

On the subject of noise the White Paper states that, at Gatwick, this would seriously affect "comparatively few people," and every practicable step would be taken to reduce it.

Assurances had been obtained from the Air Corporations and B.I.A.T.A. to the effect that Gatwick would be suitable for their purposes and would be used by them. It was hoped that Gatwick would be in operation by the summer of 1958, by which time the traffic at London Airport would be in excess of that which could be handled effectively in all conditions. The matter was therefore one of "a good deal of urgency." Some accommodation in the immediate vicinity would be required by the Ministry of Transport and Civil Aviation, and some of the existing properties close to the perimeter would undoubtedly prove suitable. The Ministry would be ready to purchase such properties if the owners wished to sell them. B.E.A. had also assured the Minister that they would need accommodation for themselves and their staffs in the immediate vicinity. It would be necessary to build a diversion of the Brighton Road (A23) and work on this, and on a road giving improved access to the airport, would be begun in the near future.



First- and second-phase development of Gatwick airport, related to the environs. (Based on an official map of the project.)

The White Paper concludes with the statement that:

> "The Government fully realize the natural disappointment which this decision will cause to the residents in the area immediately affected. But after the most prolonged and exhaustive consideration of the whole matter and all the possible alternatives, the Government find the conclusion inescapable that the development of air transport in this country renders it important in the national interest to proceed without delay with the development of this airport. They will . . . do their best to mitigate the inconvenience which this decision must involve to a number of people in this area. But, after hearing and giving full weight to every argument and giving to the matter prolonged and anxious thought, they have no doubt at all that they must proceed with the Gatwick development."

Gatwick will have a threefold rôle to play: (a) to be the main alternate aerodrome for diversions from London Airport; (b) to take over from London Airport certain services, particularly to the Channel Islands and near-Continental points, which operate at seasonal peaks; (c) to be a base for some of the charter companies at present sited at aerodromes which are to be closed down.

Development is planned in two stages. The first (to be completed, as already stated, by the summer of 1958) entails putting down a 7,000ft runway, with taxi-ways, terminal area and buildings, control tower and part of a maintenance area. The development of this stage will entail the acquisition of 290 acres of land, in addition to 370 acres within the present airfield boundaries. The diversion of the Brighton Road will be part of Stage I development, as will be the closing of the present Gatwick Airport Station and the reopening and development of Gatwick Racecourse Station. A loop-line will be provided and that station will have a road access to the diverted A23 and a footbridge to link it with the airport terminal building. By the time the developed airport is open in 1958 the British Transport Commission should have so reorganised its services that the airport will be served by four trains in and out of London—two fast and two semi-fast—each hour. Special two- or four-coach portions will be attached for the journey between London and the airport.

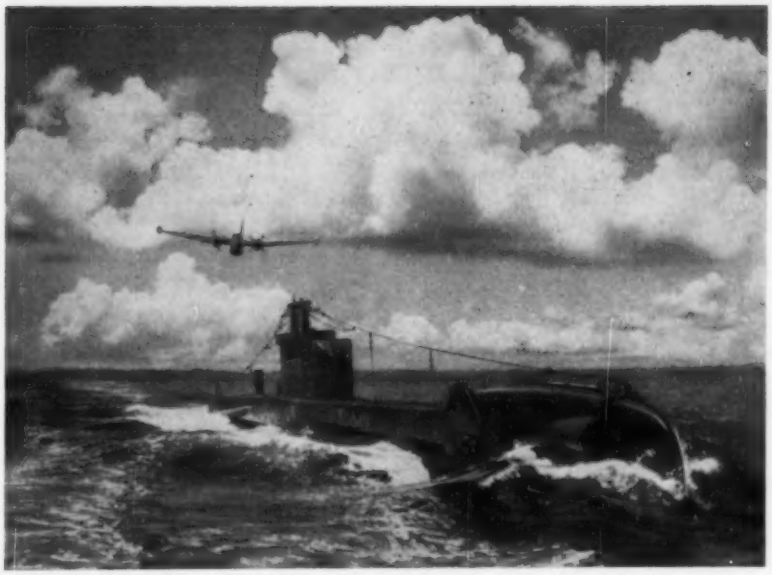
The estimated cost of Stage I, including acquisition of the land, building, road diversions, and contributions towards rail and river works, is £6 million.

If Stage II is proceeded with it will entail putting down a second main runway of 6,000ft, with taxi-ways, and possibly a subsidiary runway (4,000ft). It is far from certain, however, that either of these schemes will prove to be necessary.

Mr. Boyd-Carpenter was asked in the House of Commons on October 20th if he was aware that there was a considerable body of opinion to the effect that, owing to the development of the helicopter, the new airport would be redundant very soon after it was built. He was asked if it would not be far wiser to spend the large sum of money involved on the development of helicopters, in which field we were at present so far behind the Americans. Replying, the Minister said that we were anxious to make the best possible progress with the helicopter, but he really did not think that the development hoped for in that direction affected in any degree the need for Gatwick Airport. The helicopter might well develop traffic additional to—not in substitution of—the services operated by fixed-wing aircraft.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News



Against a background of tropical clouds a R.A.A.F. Neptune makes a pass at H.M.S. "Thorough" as it ploughs through Seeadler harbour, Manus Island, in Operation Satex One completed last weekend.

Aries IV Over North Pole

THE first flight by an R.A.F. jet aircraft over the geographical North Pole was made on the night of October 14-15th by the Canberra *Aries IV* belonging to R.A.F. College, Manby. The aircraft took off from Bardufoss, north of Narvik, at 2100 hours on October 14th and climbed steeply to 40,000ft. From then on cruise climb technique was used until a height of approximately 50,000ft was reached somewhere on the return leg from the Pole. Bad weather precluded a return to Bardufoss and *Aries IV* finally landed at 0400 at Bodö. Total distance covered was 3,026 miles in 6¾ hours. The minimum temperature encountered was −76 deg F.

The captain of *Aries IV* was W/C. A. H. Humphrey, O.B.E., D.F.C., senior instructor of the College, with S/L. D. Bower, M.B.E., senior navigation instructor, and F/L. F. R. Wood, as first and second navigators respectively. Navigation during the flight was principally astro and is reported to have been uneventful except for some difficulty due to instruments freezing up in the low temperatures.

Aries IV was seen off at Bardufoss by the Commandant of the College, A/Cdre. G. A. Walker, C.B.E., D.S.O., D.F.C., A.D.C., who flew the supporting Hastings out from Manby. General O. Bull, Commander of the Royal Norwegian Air Force, Northern Norway, welcomed the crew when they landed at Bodö.

It will be remembered that W/C. Humphrey flew *Aries IV* on its record-breaking flight from Cape Town to London in 13¼ hours last year, and that S/L. Bower was navigating on that occasion. F/L. Wood was then briefing officer at R.A.F. Idris. All those engaged on this latest College venture have had previous experience of Polar flying.

Britannia Shield

AT the conclusion of the boxing events at Wembley on Wednesday, November 10th, the Duke of Edinburgh has promised to present the Britannia Shield.

The seven countries competing this year are: Belgium, France—after a lapse of two years—the Netherlands, Norway, Canada, the United States and Great Britain. Events comprise fencing, swimming, shooting and boxing. Last year Great Britain won the Shield.

The Britannia Shield trophy was made from oak from Guildhall, London, damaged by enemy action. It was presented by S/L. E. S. Virpsha, R.A.F., a naturalised Polish officer, now retired. All profits from the competition go to the R.A.F. Benevolent Fund for the benefit of the Britannia Shield Fund, which assists sons and daughters of R.A.F. personnel, and particularly dependents of those killed in the Battle of Britain, to complete university courses.

Pacific Maritime Exercises

THE maritime exercise Operation Satex One, in which the Royal Australian Air Force, the Australian Fleet and the British Far East Fleet took part, came to an end on October 20th.

In the final phases the two submarines *Thorough* and *Tactician* suffered badly during attacks. Neptunes and Lincolns, together with carrier-based aircraft from H.M.A.S. *Sydney* forced them to remain submerged for long periods. In the last phase of the exercise the submarines were able to attack on three occasions only.

Rear-Admiral Gladstone, flying his flag in *Birmingham*, is reported to have said that the attacks by the *Sydney's* aircraft were well co-ordinated and had shown that any surface boat operating without air cover would be entirely at the mercy of enemy aircraft.

In these operations the carrier-based aircraft flew low over *Birmingham* and other ships and were not detected by radar until the last moment. Both *Birmingham* and *Tactician* were considered sunk.

R.A.F. Canal Zone Facilities

THE firm of International Aeradio, Ltd., has been invited by the Air Ministry to provide services for the R.A.F. in the Suez Canal Zone after the withdrawal of military forces in accordance with the Anglo-Egyptian Agreement.

Under the terms of the agreement, R.A.F. flights staging through the Canal Zone, after prior notification to the Egyptian authorities, will be permitted to use Abu Sueir airfield (landplanes) and Fanara (flying-boats). International Aeradio, Ltd., will provide certain services for this purpose. Other facilities will be provided by the Egyptian Air Force to whom airfields will be handed over. The resources of I.A.L. which will be required to meet the special needs of the Royal Air Force, will equally be available to the Egyptian Air Force. The company expects to base in the area only a small number of British technicians, the majority of its employees being Egyptian nationals.

R.A.F. Appointments

AMONG recent R.A.F. appointments are the following: G/C. J. H. Lapsley, O.B.E., D.F.C., A.F.C., has gone to Oldenburg; G/C. A. Forbes Johnson to Gibraltar; G/C. J. P. Cave, O.B.E., to Air Ministry Unit; G/C. G. F. Rodney,

On Wednesday, October 13th, the Duchess of Gloucester, Air Chief Commandant, W.R.A.F., visited Aldergrove. Left to right are: F/O. N. H. D. Cooper, G/C. K. W. Niblett, D.F.C. (Station Commander), the Duchess of Gloucester, Air Commandant N. H. Salmon, O.B.E., A.D.C. (Director of the W.R.A.F.), W/C. A. N. Jones, A.F.C., and P/O. K. M. Armstrong, W.R.Aux.A.F.

SERVICE AVIATION . . .

D.F.C., A.F.C., to Ahlhorn; and G/C. R. C. Ayling to Marham, all in command.

G/C. J. M. Thompson, D.S.O., D.F.C., A.F.C., is at Central Flying Establishment for directing staff duties as is W/C. W. D. Hodgkinson, D.F.C., A.F.C., at the Joint Services Staff College. For air staff duties G/C. P. G. Jameson, D.S.O., D.F.C., has gone to No. 11 Group; G/C. N. W. Wakelin to No. 43 Group and W/C. G. H. Gatheral to Transport Command.

G/C. B. H. Becker and W/C. P. W. Nunn, B.E.M., are in the Department of the Air Member for Personnel and W/C. V. Fairfield in the Department of the Air Member for Supply and Organization.

Appointments for technical staff duties include those of G/C. H. Stringer, O.B.E., to No. 205 Group; W/C. B. E. Dunkerley to H.Q. M.E.A.F.; W/C. A. R. Atkins to British Forces Aden H.Q. and W/C. A. D. Adams to No. 81 Group. For administrative staff duties G/C. W. J. R. Cann has gone to 2nd T.A.F. and W/C. I. G. H. Drummond to No. 25 Group.

W/C. E. R. M. Walker is now at Bircham Newton and W/C. E. G. Farthing at St. Athan, both for administrative duties.

For technical duties W/C. J. D. Greaves has gone to Merryfield; W/C. H. Simmons to Church Lawford and S/L. R. Storey, with the acting rank of wing commander, to Nicosia.

S/L. J. R. Brown, also with the acting rank of wing commander has been appointed to command No. 5352 (Airfield Construction) Wing.

Canadian R.M.C. Appointment

SUCCEEDING Brigadier D. R. Agnew, who is retiring, A.Cdre. D. A. R. Bradshaw, D.F.C., R.C.A.F., has been appointed commandant of the Royal Military College at Kingston, Ontario. A. Cdre. Bradshaw's post as Chief of Training at A.H.Q. has been taken over by G/C. V. H. Patriarche, O.B.E., A.F.C., C.D.

R.Aux.A.F. Appointment

THE appointment has been announced of S/L. P. J. Briggs, D.F.C., to command No. 504 (County of Nottingham) Squadron, R.Aux.A.F. The unit is based at Wymeswold, Leicestershire.

S/L. Briggs has been with the squadron since February 1950. His wartime service was mostly in units of Bomber Command and it was while serving with No. 171 Squadron that he was awarded the D.F.C.

The I.D.C. Course

THE following Royal Air Force officers have been selected to attend the 1955 course at the Imperial Defence College:—A. Cdre. H. R. Graham, D.S.O., D.F.C.; A. Cdre. J. D. Miller, C.B.E.; A. Cdre. S. Widdows, D.F.C.; G/C. J. G. Davies, C.B., O.B.E.; G/C. O. R. Donaldson, C.B.E., D.S.O., D.F.C.; G/C. S. W. R. Hughes, O.B.E., A.F.C.; G/C. B. J. R. Roberts; G/C. F. S. Stapleton, D.S.O., D.F.C.; and G/C. C. J. Salmon, O.B.E. Five members of Commonwealth Air Forces will also attend.

St. Merryn to Close

IT is officially announced by the Admiralty that the Royal Naval Air Station St. Merryn, on the north Cornish coast, is to close. In making the announcement the Admiralty give as the reason the need to achieve the maximum economy.

The shutting down will not be immediate. No change at all is expected until next spring but the closure is to be completed within two years. St. Merryn is at present commanded by Capt. R. W. F. Northcott, R.N.

Gordon Shephard Prize

OPEN to all serving members of the Royal Air Force for annual competition, the Gordon Shephard Memorial Prize Essay has been won this year by W/C. W. G. Lawrence, M.I.E.E., G/C. E. A. Whiteley, D.F.C., was second and W/C. H. D. Newman, O.B.E., was third.

Competitors were asked to write on the effect of specialization, as brought about by the increasing complexity of modern weapons, on the training of officers in the General Duties (Flying) Branch and to suggest how the opposing requirements of specialization and wide experience can best be resolved.

The Sunderland Accident

FOUR men of No. 230 Squadron lost their lives last week-end when a Sunderland in which they were flying met with an accident while attempting to alight in Tveraa Fjord in the Faroes to pick up a critically ill British seaman and convey him to hospital in Scotland. Reports from the Faroe Islands said that the flying boat was struck by a squall just as it touched the water, causing it to capsize and sink almost immediately.

Those who lost their lives were: F/L. J. R. Hill, F/O. A. A. Howardson and Sgt. A. S. Cronk. F/S. E. Davies died later in hospital. The two pilots, S/L. E. C. Bennett, who commands the squadron, and F/L. J. S. M. Jones were both seriously injured and are in hospital. The remainder of the aircrew returned in H.M.S. *Pincher*.

Reunion

THE eighth annual reunion of No. 87 Squadron is to be held at the New Inn Restaurant, Westminster Bridge Road, London, S.E.1, at 1830 hr on Saturday, November 13th. Particulars from A. B. Ebrey, "Seaforth," Southfield, Hessle, East Yorkshire.

No. 2 WING R.N.A.S. DINES

AT their 13th reunion dinner held last Saturday in London, No. 2 Wing, R.N.A.S., Eastern Mediterranean, H.M.S. *Ark Royal* and *Canning*, 1915-1918, had as their guests Vice-Admiral Sir John Eccles, who is now Flag Officer (Air) Home, at Lee-on-Solent and Capt. D. R. F. Cambell and other senior officers of the new *Ark Royal* now fitting at Birkenhead. No. 2 was the Wing that operated the "giant" Handley Page 0/400 aircraft from Mudros against the Turks. Among their aircrew were Jack Alcock and Arthur Whitten Brown, who later were both knighted after making the first non-stop flight across the Atlantic in 1919. Bert Hinkler was a mechanic with the Wing.

There were 79 at the dinner. The secretary, Mr. A. G. Furlong, read letters from members all over the world—including an invitation from Mr. Richards to anyone holidaying in the Isle of Wight—he is now the governor of Parkhurst Gaol!

Admiral Sir Reginald Portal, who was in the chair, told how they had tried to get the bell of the old *Ark Royal* to present it to the new ship. Eventually it was found to be in the possession of the 1914 *Ark Royal*'s first captain, now Air Marshal Sir Robert H. Clark Hall, who unfortunately could not part with it because it was already tied up with a legacy. In its place a presentation was made of a framed photograph of the old seaplane carrier to be hung in the wardroom.

In speaking of the guests from the new carrier Sir Reginald reminded his listeners that Capt. Cambell was the inventor of the angled deck and, as a final compliment, said they represented naval flying as it is today and were the direct descendants of the present company. "If they are not proud of us," he said, "at least we are proud of them."

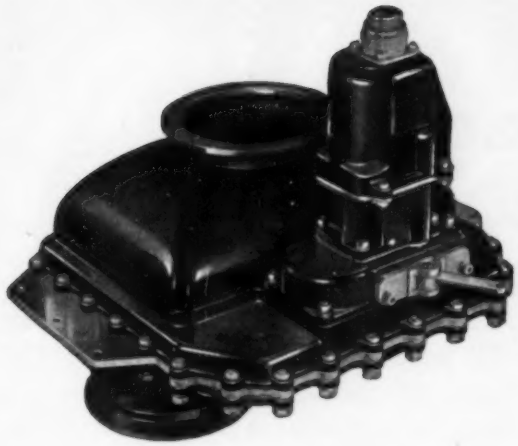
Captain Cambell, replying, said how pleased they were to meet the people who created the fame of a ship which was temporarily in their hands. He said they were actively engaged in writing a history of the *Ark Royals* and would be glad of any matter, especially photographs.

He gave a picture of a fleet forming round five new carriers and gave some figures for the latest *Ark Royal*. It is 812ft long, he said, of 50,000 tons and the flight deck had an area of three acres. There is accommodation for 60 modern aircraft and it had an angled deck, steam catapult and very powerful arrester gear. The wardroom would have to cater for the equivalent of the total complement of a Daring class destroyer and a cafeteria system was necessary to feed the lower deck. Total complement exceeded 2,000 men; its first commission would start next February.

W/C. W. R. Parkhouse proposed the toast of the Fleet Air Arm and Vice-Admiral Sir John Eccles, in replying, recalled his first memories of operating aircraft from warships—when they flew from platforms over the gun turrets of H.M.S. *Indomitable*. He recalled, also, a demonstration of the crash barrier when it first came into being—this was made to reassure pilots who looked askance at it. A Swordfish with dummy crew was linked to a catapult which was then operated. Unfortunately, instead of running along the deck straight into the barrier, the Swordfish took off, rose a few feet and tripped over it, finishing up in a mangled heap upside down on the forward deck.

The final toast of the evening, "Our chairman and president," was given by Mr. W. Pollard who recalled the party given in a Bessonneau hangar on Mudros when G/C. Smyth-Piggott (president) was awarded the D.S.O.—and how he remembered meeting Admiral Portal in the *Bacchante* as a very young officer, keen to fly.

G/C. Smyth-Piggott regaled the company with anecdotes from the earliest days of naval flying. How he had applied to go with Capt. Murray Sueter and Lt. Neville Usborne to build the airship Mayfly (it didn't); to receive the reply from the Admiralty "This young man must learn his knots and splices first"! When Frank (now Sir Frank) McClean offered to train, free of charge, four naval pilots he again applied, to be again turned down. In disgust he gave up his commission and went to Malaya to plant rubber. From there he made another application to be one of 20 pilots the Admiralty wanted and was accepted. Whilst learning he crashed and broke both legs. Even this he turned to some account because the Admiralty insisted on his going to sea to take his watch-keeping certificate—he regretted that this was quite impossible because the steel plates on his legs would upset the compass! He did not go to sea. J.Y.



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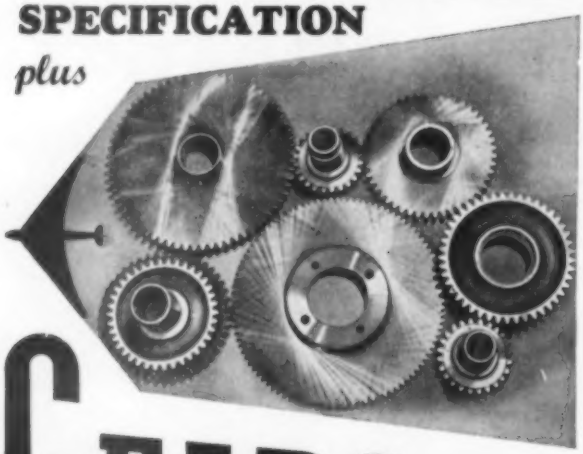

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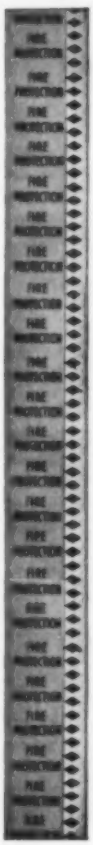

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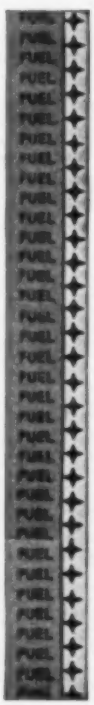

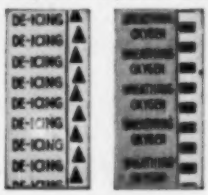

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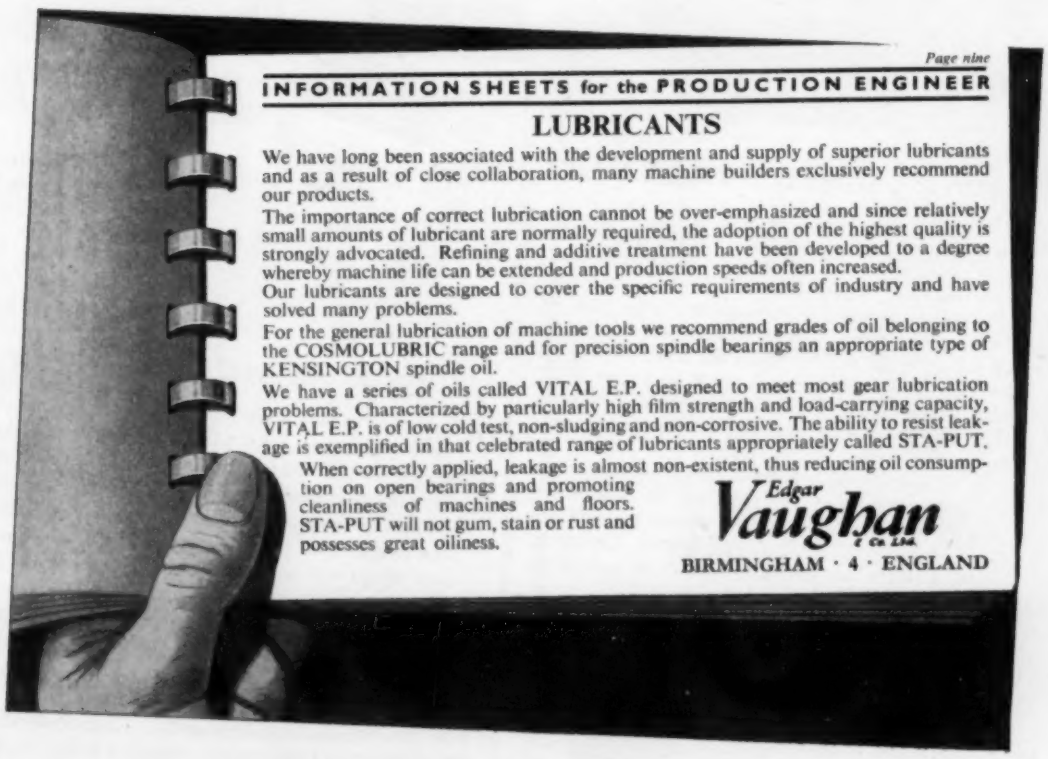

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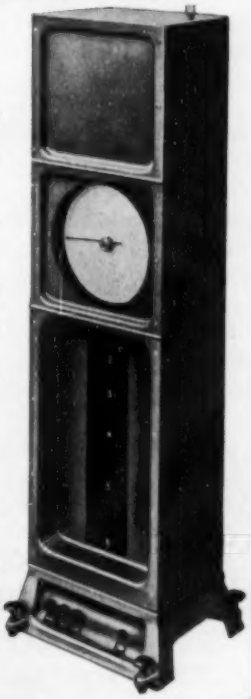

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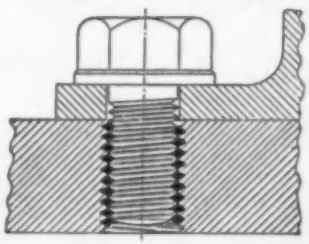
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PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:—

APPLICATION No. 397 from British European Airways Corporation, of Keyline House, Ruislip, Middlesex, for a normal scheduled service with Pionair, Elizabethan and/or Viscount aircraft for the carriage of passengers, supplementary freight and mail between London Airport and Las Palmas and/or Teneriffe, with an intermediate traffic stop at Gibraltar, at a frequency of from one to seven services weekly during the period from January 1st, 1955, to December 31st, 1964.

APPLICATION No. 17/1 from Starways Ltd., of Speke Airport, Liverpool, for permission to include a traffic stop at Birmingham (Elmdon) on their seasonal inclusive tour service undertaken in conjunction with the Cathedral Touring Agency, between Liverpool (Speke) and Tarbes (for Lourdes) (Application No. 17) approved by the Minister of Transport and Civil Aviation for operation during the season from May to October inclusive each year, up to October 31st, 1957.

APPLICATION No. 398 from Dan Air Services Ltd., of Bilbao House, 36-8 New Broad Street, London, E.C.2, for a seasonal inclusive tour service with Dakota aircraft in conjunction with Village Franco-Britannique of Calvi, for the carriage of passengers and supplementary freight between London (Blackbushe) and Corsica (Calvi) at a frequency of from one to two services weekly during the season from May to September inclusive each year, for a period of seven years, commencing May 29th, 1955.

APPLICATION No. 21/2 from Cambrian Air Services Ltd., of Cardiff (Rhoose) Airport, Barry, Glam., for permission to operate, where appropriate, and for the remainder of the periods of approval, Dakota aircraft in addition to the aircraft types already approved on all their U.K. internal and normal scheduled services which have been approved by the Minister of Transport and Civil Aviation.

APPLICATION No. 400 from British European Airways Corporation, of Keyline House, Ruislip, Middlesex, for a normal scheduled service with Viscount and Elizabethan aircraft for the carriage of passengers, supplementary freight and mail between London and Venice (Treviso), at a frequency of from four to seven services weekly during the period from April 1st, 1955, to March 31st, 1965.

THESE applications will be considered by the Council under the terms of reference issued to them by the Minister of Civil Aviation on July 30th, 1952. Any representations or objections with regard to these applications must be made in writing, stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [2807

PUBLIC APPOINTMENTS

THE COLLEGE OF AERONAUTICS

Chair of Aircraft Electrical and Electronic Engineering

THE governing body invites applications for the newly-created post of professor and head of the department of aircraft electrical and electronic engineering. Candidates will be expected to have a sound general knowledge of the whole field of aircraft electrical and electronic engineering, as well as extensive and up-to-date knowledge and experience of some important branch. Candidates must be capable of administering a department, teaching and supervising studies at a post-graduate level, and engaging in research as well as directing a programme of research within the Department and in co-operation with other Departments in the College. The salary range for the post is £1,700 to £2,000 per annum, with superannuation under F.S.S.U. and family allowances. The initial salary will be dependent upon the qualifications and experience of the successful candidate.—Applications, giving full details of qualifications and experience, and quoting the names of three referees, should be addressed to the Principal, The College of Aeronautics, Cranfield, Bletchley, Bucks., preferably not later than November 30th, 1954. Further particulars available. [2806

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Electronic Engineer with good practical and theoretical background required to perform pre-flight measurements on a missile guidance system. Experience, initiative and adaptability required for this work. Working away from base for periods os a few days may be necessary. Any previouf experience of a similar nature would be an advantage. (Ref. 78.)

LABORATORY ASSISTANTS AND JUNIOR ELECTRONIC ENGINEERS

required for a number of posts in the Research and Design Laboratories of an advanced Guided Missile project. The work is interesting and prospects for advancement are good. For most of these posts graduates are required, or applicants holding National Certificate or City and Guilds with some practical experience. Lack of these qualifications should not prevent application being made as each case will be considered on its merit. (Ref. 80.)

SENIOR AND JUNIOR ASSISTANT PHYSICISTS

required in a Guided Missile project for research and development work. Qualifications must include a degree in physics and two years' industrial experience for the senior posts and Inter B.Sc. or equivalent for the junior posts. Knowledge of electronics an advantage. (Ref. 81.)

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I.54, Personnel Manager.

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4. Licensed instrument engineers and inspectors with category "X" endorsement.

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THE COLLEGE OF AERONAUTICS

APPLICATIONS are invited for the post of Lecturer in the Department of Aircraft Propulsion. Candidates should have advanced knowledge of some branch of thermodynamics or gas dynamics, and of the theory and performance of propulsion units, and some practical experience of one or more modern propulsion systems. They should possess a degree and/or other recognised professional qualification. Salary within range £600-£1,000 per annum depending upon qualifications and experience, with superannuation under F.S.S.U. and family allowance. A small house on the college estate may be made available.—Applications, giving full details of qualifications, etc., and quoting the names of three referees should be addressed to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. Further particulars available. Closing date for applications, November 12, 1954. [2747

ELECTRICAL ENGINEERS

THE National Research Council, Ottawa, Canada, requires research engineers to investigate problems in the practical application of electro-thermal aircraft de-icing. This will include tests in flight and in icing tunnels, and the development of heater pads and controls in co-operation with aircraft firms. University graduation in electrical engineering with experience in aeronautical engineering and preferably in aircraft electrical design and development is required. Flying experience is desirable. Salary up to $5,750 per annum depending on qualifications. Applicants should write to the Employment Officer, National Research Council, Sussex Street, Ottawa 2, Ontario, Canada, and enclose a résumé of qualifications and experience. Please refer to File ME-326. [2810

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ONE "D" licence engineer required, with experience on light aircraft engines.—Apply, Chief Engineer, Derby Aviation, Ltd., Derby Airport, Derbys. [2804

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THE Bristol Aeroplane Company Limited requires two qualified and experienced work study engineers to teach work and methods study.

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THE ENGLISH ELECTRIC Co., Ltd., Guided Weapons Division, Luton, has vacancies for all grades of senior and junior staff in the Electronics Department, as follows:—

SENIOR engineer, with experience of production engineering of prototype electronic equipment and a working knowledge of electronic circuitry.

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SENIOR engineer with a wide experience of radar and communications equipment maintenance.

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THESE are permanent and progressive posts, and attractive salaries are offered to the right men. Staff pension after qualifying period.—Applications to Dept. C.P.S., 336/7 Strand, W.C.2, quoting Ref. 1164B. [2785

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Applications, giving details of experience, qualifications and salary required, quoting D.O.25, should be addressed to:—

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The Bristol Aeroplane Co., Ltd.,
Aircraft Division,
Filton House, Bristol.

SITUATIONS VACANT

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THE ENGLISH ELECTRIC CO., Ltd., Luton, require a junior engineer with a degree or H.N.C. in mechanical engineering to assist in the design of guided missile rocket motors.—Apply to Dept. C.P.S., 336-7 Strand, W.C.2, quoting Ref. 1325E. [2770

CHIEF flying instructor with A.L.T.P. licence wanted with possible endorsements for Viscounts, Yorks, Vikings and Dakota aircraft.—Reply in writing, Chief Pilot, Hunting-Clan Air Transport, Ltd., London Airport, Heathrow. [2790

NORMALAIR LTD., have vacancies in Yeovil for design draughtsmen, D.O. checkers, technicians, stressmen, liaison engineers, for work on aircraft pressurising and high altitude breathing equipment and cold air units.
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LOCAL interviews arranged where convenient. [0346

ARMSTRONG SIDDELEY MOTORS require senior draughtsmen (30-35 years) for the design of special handling equipment for the manufacture of gas turbine engines and rocket motors. Position carries close liaison with the Services and airframe manufacturers. Applicants must be able to direct and co-ordinate work of others. Junior draughtsmen are also required for detail work on the above. The Company is expanding and offers excellent prospects for the right type of man.—Apply in detail to Reference CG/SDI, Technical Personnel Officer, Armstrong Siddeley Motors, Coventry. [2769

SCHEDULE clerk required for the preparation and maintenance of spares schedules in connection with gas-turbine and internal-combustion aero engines. Applicants must have had previous experience.
PLEASE write, giving age and details of previous experience, to the Personnel Officer, The de Havilland Engine Co., Ltd., Stag Lane, Edgware, Middlesex. [2793

CHIEF stressman is required by Normalair, Ltd., to be responsible for strength calculations in connection with aircraft pressurising and air conditioning equipment, including cold air units and high altitude breathing equipment, and other new projects. An engineering degree or equivalent is essential.
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WHERE convenient, interviews will be arranged locally and on Saturdays.
WRITE, for an application form, to the Personnel Officer, Dept. P/14, Saunders-Roe, Ltd., East Cowes, Isle of Wight. [2782

DESIGN draughtsmen, all grades, urgently required on electrical and electronic apparatus for guided weapons and allied projects.—Please write in detail, or send postcard for application form, to the Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [0611

ARMSTRONG SIDDELEY MOTORS have a vacancy in their technical illustrating department for an experienced technical artist, aged 24-26. Staff position, salary according to age, experience and qualifications. Replies should be addressed to Reference CG/TA1, Armstrong Siddeley Motors, Coventry. [2722

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MATHEMATICIAN or stressman with experience of aircraft C.G. calculations required immediately.—Please write, in detail, or send postcard for Form of Application to: (Ref. 89) The Personnel Manager (Technical Employment), De Havilland Propellers Limited, Hatfield, Herts. [2803

SENIOR stress assistant required for interesting work on interior design and fuselage structures of large airliners. Preferably 3 years' aircraft stressing experience and H.N.C. or equivalent.—Apply to Chief Stressman, Baynes Aircraft Interiors, Ltd., Langley Aerodrome, Slough, Bucks. [278

FIRST-CLASS mechanical design draughtsmen are required for interesting and important projects.—Please write in detail or send postcard for application form to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [0610

DRAUGHTSMEN, sound experience aircraft structures, urgently required for interesting work in London and Portsmouth areas by large engineering organisation. Salary £12 per week upwards plus a living allowance if from outside the district. Pension scheme.—Please write, giving full particulars of experience and qualifications, to Box 8360. [2736

DRAUGHTSMEN required in the design office. These appointments are pensionable and offer good prospects to individuals with initiative and technical ability.—Applications, giving details of experience and qualifications should be sent to the Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham 28 2787

SENIOR and junior stressmen vacancies for interesting programme of project and development work. Previous experience not essential for junior posts. H.N.C. minimum qualification. Salary in accordance with experience and qualifications.—Full particulars in writing to Personnel Manager, Flight Refuelling, Ltd., Tarrant Rushton Airfield, Nr. Blandford, Dorset. [2792

DRAUGHTSMEN, sound experience aircraft electrical work, urgently required for interesting work in London and Portsmouth areas by large engineering organisation. Salary £12 per week upwards plus living allowance if from outside the district. Pension scheme.—Please write, giving full particulars of experience and qualifications, to Box 8361. [2737

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VACANCIES exist in the Installation Department of Smiths Aircraft Instruments, Ltd., Cheltenham, for Aeronautical or Electrical Engineers having experience of electric and hydraulic servo mechanisms, radio navigation equipment, gyro magnetic compasses and experimental flight testing. A good general knowledge of aircraft construction and operation is essential.

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APPLICATIONS, with details of qualifications, experience and salary required, should be made in writing to the Personnel Department, Smiths Aircraft Instruments Limited, Bishops Cleeve, near Cheltenham, Glos., quoting reference number 42/EN. [2742

HELLIWELLS Ltd., Aircraft Division, Elmdon Airport, Birmingham, urgently require draughtsmen, all grades, preferably with aircraft installation experience, but others with good light engineering experience considered. The work is interesting and of high priority, and good opportunities of advancement with this expanding company are open to the right men. —Send full details to Personnel Manager. [2749

AERODYNAMICIST and a mathematician or physicist are required for an expanding group engaged in research and development of guided weapons for work on non-linear mechanics. Applicants should have an honours degree and preference will be given to those with research experience.—Please write, with full details, to Personnel Dept. (ED/183), E.M.I. Eng. Dev., Ltd., Hayes, Middlesex. [2791

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ARMSTRONG SIDDELEY, Coventry, have vacancies on interesting important work in stress department on strength investigations and calculations—gas turbines. Higher National, engineering or mathematics degree minimum qualification, experience unnecessary. Same department invites similarly qualified applicants for work on engine installation in prototype/experimental aircraft.—Reply, Reference CG/DRE.1, Technical Personnel Officer, Armstrong Siddeley Motors, Coventry. [2784

JOSEPH LUCAS (GAS TURBINE EQUIPMENT), Ltd., have vacancies for designers and development engineers at their Marston Green and Shaftmoor Lane factories. Experience of aircraft electrics or hydraulics would be an advantage, but not essential. These appointments are pensionable and offer good prospects to individuals with initiative and technical ability.—Applications, giving details of experience and qualifications, should be sent to the Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham 28 [2788

SENIOR scientific officers, scientific officers, patent examiner and patent officer classes. The Civil Service Commissioners invite applications for pensionable appointments. Applications will be accepted up to December 31, 1954. Interview boards will sit at frequent intervals. The scientific posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small; individual vacancies exist at present for candidates who have specialised in palaeobotany, foraminifers, malacology and lichenology. The patent posts are in the Patent Office (Board of Trade) and Ministry of Supply.

CANDIDATES must have obtained a university degree with first- or second-class honours in an appropriate scientific subject (including engineering) or in mathematics, or an equivalent qualification; or for scientific posts possess high professional attainments. Candidates for senior scientific officer posts must, in addition, have had at least three years' post-graduate or other approved experience. Candidates for scientific officer and patent posts who took their degree examination in 1954 may apply before the result is known.

AGE limits: senior scientific officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For scientific officers and patent classes, between 21 and 28 during 1954 (up to 31 for permanent members of the experimental officer class). Salary (London), senior scientific officers, (men) £975-£1,150, (women) £845-£1,025; scientific officers, (men) £470-£855, (women) £470-£750; patent examiner and patent officer classes, (men) £440-£760 (rates under review), women's rates somewhat lower. Somewhat lower rates in the provinces.

FURTHER particulars from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S/53/54 for senior scientific officers and S. 52/54, S. 128/54 for the other posts. [2794

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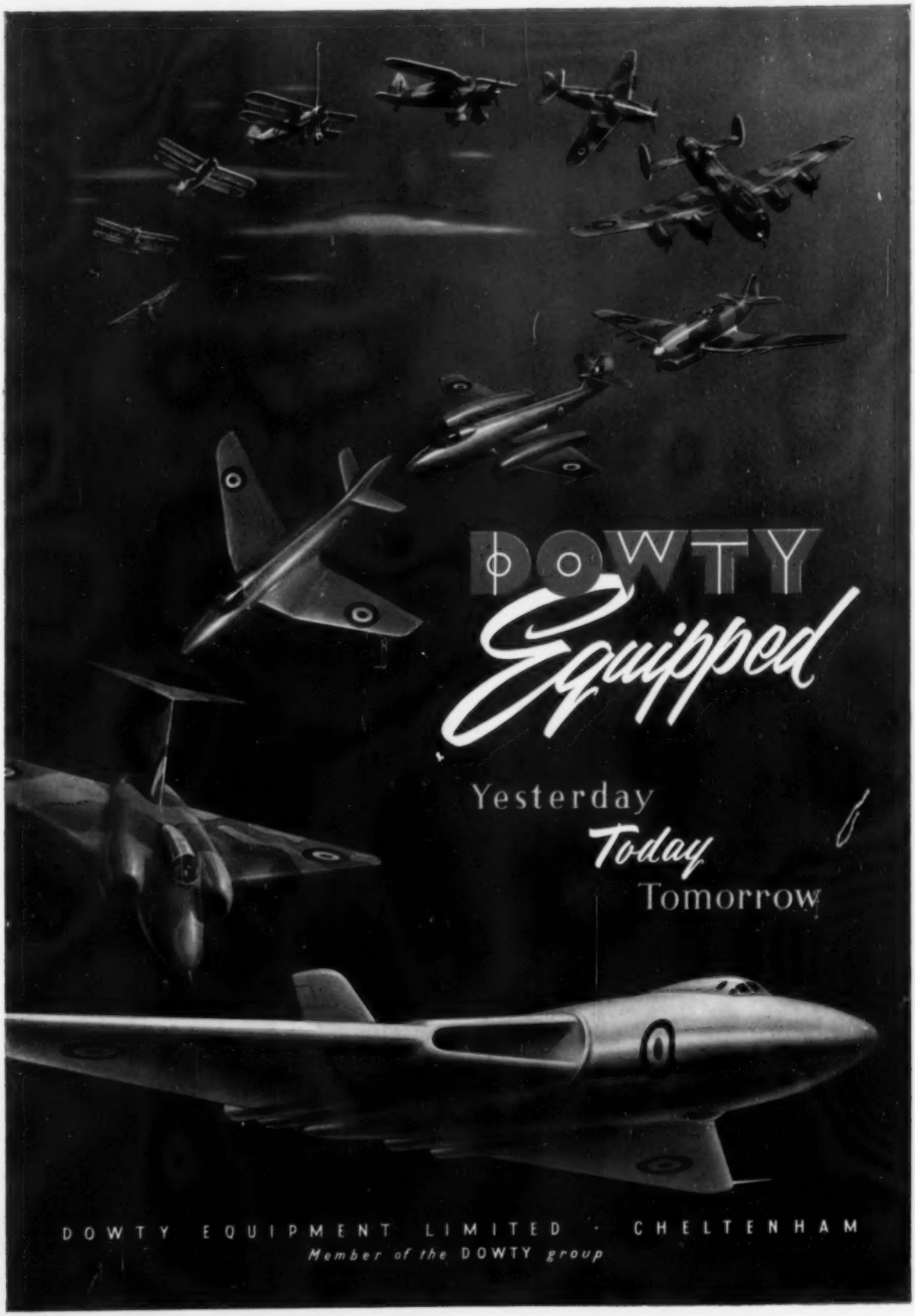
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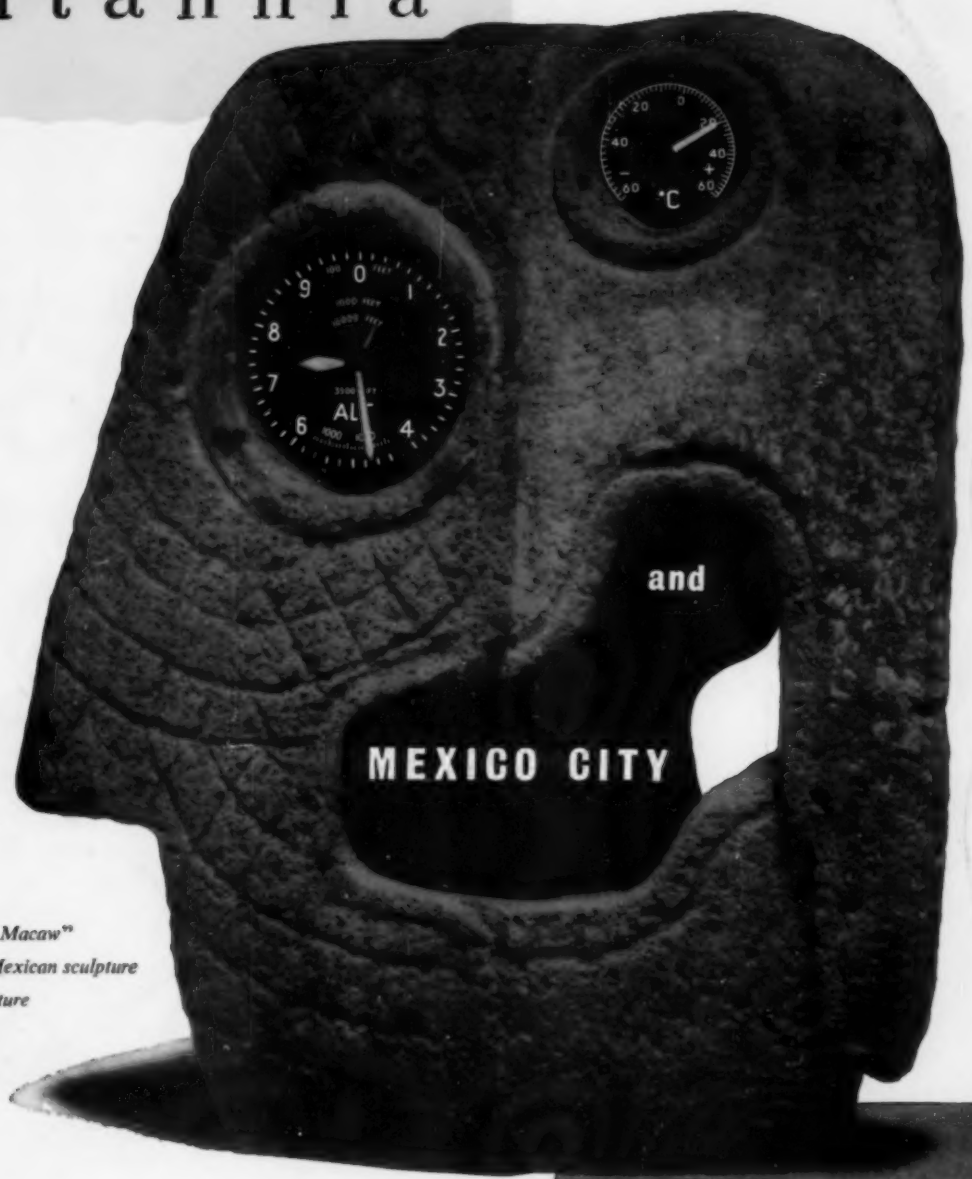

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